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THANKSGIVING.

During the week just passed the people throughout our land have again, and in accordance with ancient custom, and the recommendation of National and State authorities, participated in and perpetuated the good old custom of an annual thanksgiving for the blessings of the year. Around many a festive board have the parents and children, and children's children, gathered to renew the affections of years gone by, to form new ties that shall in future bind many hearts more closely; and by the mere fact of coming together, simply for social pleasure, to learn new lessons of self-knowledge and the knowledge of others. It is a good custom, and one that should never be allowed to pass oway. There are too few holidays of this kind, and those we have should be cherished.

In every department of life, in every business, trade, or occupation, there surely must be some cause for thankfulness as the year draws to its close. Sometimes these causes may be more difficult to define than at others; but dark and dreary must be the lot of the man who can find nothing to be thankful for if he makes a really honest search.

So far as our own industry is concerned, that of gas manufacture, the year passed has been one of prosperity and increase. In many cases the increase in the send-out may have been small, but the general outlook of the whole business is one of decided encouragement alike to the gas maker, the stockholder, and the consumer.

Throughout the length and breadth of the land there is a constant effort on the part of the gas maker to so improve his methods of proceedure that the price of gas may be made lower to the consumer. This is not from any idea of philanthropy, but simply as a matter of business, to secure at the same time a lower price to the consumer, and a better or more sure dividend to the stockholder.

In a business as hazardous as it must be admitted this is, those who invest therein are entitled to an ample remuneration, for we know full well how simple a thing may produce a disaster that will demand large expenditures to repair; and if the papers and discussions at the meetings of the different associations are to be taken as any guide towards framing a correct opinion, it would appear very evident that the best men in the business are well satisfied that with a capital representing the honest value of the plant, and with an organization arranged strictly upon business principles, the surest way to render a proper and adequate dividend safe and permanent is to give the consumer the benefit of every reduction in price that can possibly be secured by improved apparatus, more economical methods, in fact, by any means at the command of the manager.

The result of reduction in price must be an increase in the number of uses for which gas is employed, as well as an increase in the quantity consumed. It seems to us that all these things are much nearer accomplishment than they were one or five years ago—and herein is a true cause of thanksgiving.

There are other things which might be cited as apparent causes for thankfulness. It is only a short time since the whole business was threatened with disaster, destruction, death, by the subtle fluid that man has attempted to chain to the victorious wheel of his mechanical triumphs. But, alas! for the enthusiasm of inventors, the lively corpse of the gas business stalks the earth like a thing of life, and sheds the beautiful light and warmth of its presence over many a household to-day where but a few years ago the tallow candle or the kerosene lamp held undisputed sway.

To no one does a day of relaxation come with more joy than to the gas maker; and it is our sincere hope that everyone of them throughout the land has enjoyed the day just passed with feelings of thankfulness and gratitude. There is nothing for him to fear as to the future of his business, if he be but true to himself and follow unhesitatingly the great fundamental principles which lie at the bottom of his profession. Let him swerve neither to the right hand nor to the left, but steadily, honestly pursue his calling, and the rewards attendant upon industry and strict attention to business will be given unto him.

Lunge, on the Distillation of Coal Tar.

We have just received a limited number of copies of Lunge's valuable and methodical work on the "Distillation of Coal Tar and Ammoniacal Liquor." This volume has commanded widespread attention at the hands of gas manufacturers in Europe, and the author brings to his treatise a complete and practical knowledge of the subjects which he discusses.

The gas managers of this country who are now so earnestly engaged in a solution of the problem as to the best disposition and treatment of their residual products, will find this book to be an invaluable aid in the prosecution of their investigations on the subject. The price of the work is $8.50, and orders for it may be sent to this office.

Mr. Stern Heard from Once More.

Edward Stern, the presiding genius of the Equitable Gas Light Company, of New York city, appeared on November 27th before the gas commission, and offered to supply the public lamps with gas at a price not to exceed $16.50 per lamp per annum. Mr. Stern further added that it was the intention of his company to supply private consumers at two dollars per thousand. In reply to a question propounded by Controller Campbell, Mr. Stern said that the gas which he proposed to supply had not yet been used in any large city; that it was a comparatively new idea; but that experiments had been conducted at the Municipal company's works which were perfectly satisfactory to Mr. Stern and the directors of the Equitable company. Gas of 25 candle power, as usual, was held out as an inducement to the authorities for its use, with the further promises of largely reduced bills, etc. The application was laid over for further consideration.

Gas Matters at Milton, Pa.

The Milton Gas Light Company, of Milton, Pa., has notified its consumers that on and after Jan. 1st the price of gas will be reduced to $2.50 per M. It will be remembered that some time ago a very disastrous fire occurred in this town, and the gas company was among the principal sufferers. The work of restoration being immediately commenced, the making of gas was suspended for only a brief space. Milton, Pa., is a township containing about 4,000 inhabitants, and is of some importance as a manufacturing center. The president of the company, Mr. R. F. Wilson, informs us that his gas, in his opinion, is the cheapest in Pennsylvania, the population, situation and surroundings of the place being taken into consideration—and he hopes to bring it still lower. Penn coal is used, and tar finds a ready sale at about $2.50 a barrel.

The Petroleum Outlook.

In the Cherry Grove district the production has continued falling off, until it has reached the small daily output of about 4,000 barrels. In the Bradford and Richburg regions the falling off has been gradual, and it will be likely to continue so for some months to come. The pioneer operators for the past month have developed no new field, and scarcely any extension of old fields. The most permanent strike of the month has been that of the Anchor Oil Company, on the Cooper tract in Forest county. This well is located on the center of the tract, which has an area of about a thousand acres. While it cannot be said to open up any new territory, as it is midway between two producing wells, it has given a richer yield than was generally anticipated. It struck the sand about a month since, and was estimated at about 100 barrels. Lately, drilled deeper, it produced for one day about 1,000 barrels, from which point, if we may judge from the nature of the surrounding territory, it will probably settle to a 100-barrel well of considerable duration. The wells which have heretofore been drilled in the surrounding country indicate pretty clearly that no field of any considerable extent will be opened in the district. To the northeast lies the Sheffield district, where the territory is treacherous and the wells small; to the east and southeast there are dry holes and gas; to the southwest there is the Vandergraft dry hole; and to the west lies Balltown, where there are two or three moderate producing wells and a number of fruitless ventures.

With the gradual but steady and persistent decline in the Bradford and Richburgh field, and with no new large and prolific fields in prospect, there seems to be good reason to hope for the prevalence of better prices for the coming year. It is certainly the case that those factors which regulate prices in the long run—production and consumption—are nearer equal in volume now than they have been for five or six years; and if the tendency of the past few months continues we need not be surprised to find in the early part of next year that we shall be producing less than the daily average consumption.

The runs into the pipe lines for the past month still continue large; but, from the best information we can get, we think it safe to say that these runs are largely made by reducing the stocks previously accumulated at the wells.

The new operations in the field have been fewer than for some months past. This is partly due to the fact that new territory seems to be regarded scarce, and partly to the fact that many of the more restless and active operators have become absorbed in market speculations. Lately, however, the field operator has begun to show new signs of vitality.

The export trade has been less active of late, which is probably owing to the disinclination of the foreign buyers, who still have considerable stock, to respond to the late rather sharp advance in crude.

Altogether, we believe there is better ground for faith in better prices for the coming year than we have had for a long time past.—*Petroleum Reporter.*

Utilizing Waste Dust from Coal.

At a meeting of the Engineers' Club of Philadelphia, held October 7th, Mr. W. H. Cory, of England, presented a paper upon the subject of his process for the utilization of waste dust coal, which consists in mixing the coal with a small percentage of fine, dry, fireclay and another small percentage of silicate of soda, and submitting the block to a pressure of one ton to the square inch.

The blocks are then stacked to dry and in 24 hours (the chemical action of the alumina in the clay having converted the silicate of soda into silicate of alumina, or into an insoluble substance, in that time) the blocks are fit to use, and are as hard as ordinary coal. Among the advantages claimed for this fuel are the following:

Seven per cent. more work than ordinary lump coal, there being no loss from dust falling through the fire-bars, etc.; that the fuel manufacturer can make his own silicate at little expense and trouble; that the fuel being compressed will stow in a much less space than coal; that it does not smoke, smell, depreciate in the furnace or cause clinker; that the machinery is light and inexpensive; that the cost of manufacture will not exceed fifty cents per ton, and that all descriptions of coal can be utilized, without deteriorating their burning qualities.

Mr. Cory exhibited samples made up from anthracite, bituminous and lignite coals, and ended by giving statistics showing annual waste of coal in various ways.

Some Facts about Bricks.

The *Carpenter's and Builder's Journal* contains the following:

An average day's work for a bricklayer is 1,500 bricks on outside and inside walls; on facings and angles and finishing around wood or stone work not more than half of this number can be laid. To find the number of bricks in a wall, first determine the number of square feet of surface, and then multiply by 7 for a 4 inch wall, by 14 for an 8 inch wall, by 21 for a twelve inch wall, and by 28 for a 16 inch wall.

For staining bricks red, melt one ounce of glue in one gallon of water; add a piece of alum the size of an egg, then one-half pound of Venetian red, and one pound of Spanish brown. Try the color on the bricks before using, and change to light or dark with the red or brown, using a yellow mineral for buff. For coloring black, heat asphaltum to a fluid state, and moderately heat true surface bricks and dip them. Or make a hot mixture of linseed oil and asphalt; heat the bricks and dip them. Tar and asphalt are also used for the same purpose. It is important that the bricks be sufficiently hot, and be held in the mixture to absorb the color to the depth of one-sixteenth of an inch.

A Novel Conflagration.

It is stated in one of our exchanges that a sulphur mine in Sicily was recently set on fire in a very singular manner. It seems that a wagon loaded with sulphur was being drawn up an incline when the rope attached to it broke and the wagon rushed back into the mine, as may well be imagined, at a very high rate of speed. The rapid motion developed heat enough to ignite the highly combustible ore, and the flames spread so quickly through the mine that thirteen workmen were unable to make their escape, while 30 or 40 others were seriously injured.

Opening of Proposals for Furnishing Gas.

Proposals for furnishing gas to the public offices, armories and markets, in New York city, for the year 1883, were opened, on November 28th, by the Commissioner of Public Works. The following bids were received: New York Gas Company, gas of 18 candle power, $1.50 per thousand; Manhattan, 16 candles, $1.50; Harlem, 16 candles, $2.25; Metropolitan, 20 to 23 candles, $1.50; Municipal, 25 candles, $1.75.

[Official Report—Continued from page 235.]

Tenth Annual Meeting of the American Gas Light Association.

Held at the Monongahela House, Pittsburgh, Pa.,
October 18, 19, and 20, 1882.

Afternoon Session.—Oct. 18.

Discussion on the Paper by Mr. Fogarty on "A New Process of Making Water Gas."

The President—I have no doubt that a majority of our members have followed Mr. Fogarty through his very comprehensive description of his new process; but if there are any gentlemen present who do not clearly comprehend it in its details, Mr. Fogarty will answer any questions which may be propounded.

Mr. Harbison—I have been very greatly interested in the able paper which has been read, but not fully comprehending all the points raised by Mr. Fogarty, I desire to inquire of him where this new process is in practical operation, in order that I may see it. I consider this a matter of very great importance. Thus far I have not given very much attention to the manufacture of ammonia and common salt, because I trusted to my friend, Wood, in the neighborhood, to supply me. I would like to know where I can see the results which Mr. Fogarty describes.

Mr. Fogarty—It has not yet been tried upon a practical scale, but it is about to be tested. Arrangements are now being made for the purpose of testing it upon a practical scale. It has, however, been examined by some of the best chemists in the country.

Mr. Harbison—May I inquire where it has been tested?

Mr. Fogarty—Come to me at any time after the meeting, and I will tell you all about it.

Mr. Harbison—I desire a statement for general information. Where is is being tested?

Mr. Fogarty—It is being tested in Baltimore.

Mr. Harbison—I was in hopes we would find out from the paper just what we could get for these residual products, and what it would cost to manufacture the gas by the process described by Mr. Fogarty. I do not understand him to give any definite figures, or else I have overlooked them in the reading.

Mr. Fogarty—I gave the figures as to the results of the whole process, and as to the material used—that is to say, one ton of coal and 4,277 pounds of common salt.

Mr. Harbison—How much per thousand will the gas cost in the holder?

Mr. Fogarty—I figured up the values and gave the detailed results; and anybody can figure the rest for himself.

Mr. Harbison—You do not state exactly how much it will cost per thousand.

Mr. Fogarty—No; not fully. I think the labor would be about twice what it is in the ordinary water gas process. Probably the labor would be 7 cents per thousand. I find the ultimate result, which is all I have attempted to give here, to be: From one ton of coal or coke, and 4,277 pounds of coarse salt, 42,736 cubic feet of hydrogen gas, worth 25 cents per thousand; which would be $10.68.

The President—Mr. Harbison desires to get at the cost of placing 1,000 cubic feet of hydrogen gas in the holder.

Mr. Fogarty—I cannot state that distinctly. I have calculated the ultimate products of the reactions of one ton of coal. I cannot state, without having tried the whole thing on a practical scale, to what extent these products can be realized in practice; but this is the ultimate product.

Mr. Harbison—Can Mr. Fogarty give us any idea whether we shall be able to see this process in practical operation at any time during the next twelve months? Or will he be able to tell us a year from this time what the cost will be?

Mr. Fogarty—Probably within three months.

Mr. Harbison—That is quite important to those who are remodeling their works.

Mr. Fogarty—Probably it will be in full working order inside of three months. The theoretical product would be: From one ton of coal and 4,277 pounds of coarse salt (which would be worth about $40), $584 worth of products. There is nothing more certain than that that amount of material can be evolved from a ton of carbon, and in the reaction which follows it; and it is equally certain that whenever men make up their minds that there is that much there, they will probably find a way of getting a good share of it. If they can succeed in getting one-sixth part of it they will get a good thing.

Mr. Forstall—Can you give us any idea as to what the cost of the plant would be?

Mr. Fogarty—Not yet; but so far as the cost of the gas making is concerned, it would be but very little more expensive than the plant of the present water gas. The ammonium-soda process, which will follow it, is not so expensive. It is not an expensive plant, because the greater part of the apparatus is composed of wooden tanks lined with metal.

Mr. Forstall—But you have no idea what capital outlay would be required to make a million feet of gas?

Mr. Fogarty—No; I have not got at that yet.

Mr. Forstall—I understood you to say that the cost of your gas would be about 75 cents less than nothing. That would be an answer to Mr. Harbison's question.

Mr. Fogarty—That is what I believe—that it will be 75 cents per thousand feet less than nothing.

Mr. Harbison—That will enable me to sell gas at a very low figure, and still pay respectable dividends to my stockholders; and we would be very sure in that case of having the moral sympathy of every consumer in Hartford. [Laughter.]

The President—There are present with us to-day two distinguished engineers—one distinguished as possessing an intimate knowledge of the uses and value of hydrogen gas for heating purposes, and the other mainly distinguished because of his knowledge of the value of residual products. I refer to Messrs. Goodwin and Page. Those two gentlemen would probably be able to extract from this subject the information which the members are so desirous of obtaining in detail, as to the cost and practical results of the new process.

Mr. Goodwin—This seems to be so clearly a case of residual products that it is quite out of my line of investigation; but Mr. Page can discuss that subject with you, and can give you, doubtless, all the information you desire.

Mr. Harbison—I will cheerfully resign the further cross-examination of Mr. Fogarty in favor of the senior counsel, Mr. Page.

Mr. Page—I was about to ask Mr. Fogarty one or two questions. It seems that one of the chief results of this new process is the bicarbonate of ammonia, by the soda-ammonium process. I presume that, with all the information which Mr. Fogarty has shown us he possesses upon this subject, he is also aware of the fact that the Solvays hold a patent for the soda-ammonium process in the United States. I had an interview with them at their residence in Brussels, about three months ago. They confirmed what I had learned before from Mr. Cogswell, of Syracuse (whom my friend Mr. Wood knows intimately), that works are being constructed at Syracuse for the making of soda by the soda-ammonium process; but I am very sure, from my knowledge of the matter, that it would be impossible for this company, or any other, to upset their patents. A convention of chemical manufacturers was held, while I was in England, to discuss the imminent peril which their trade was experiencing from these newer and cheaper processes of making soda. It was admitted that the cheapness with which it could be produced by the use of ammonia was such that, unless they could find some cheaper way than that which has brought so much of profit to Newcastle, Glasgow, and other manufacturing centers, the manufacture of soda would be lost to them. But, thus far, no chemist has devised any cheaper way of producing soda. I am sure that gas managers will be glad to learn that the manufacture has been fairly inaugurated on this side of the water. As yet we cannot compete with Newcastle and Glasgow; but we have reason to believe that in the near future the gas industry will furnish the means by which a successful competition may be carried on. Possibly our friend Mr. Fogarty, who is able to produce such enormous quantities of ammonia, will find a cheaper process for obtaining it than from the ammoniacal liquor. It is a pertinent fact to bring forward in connection with the paper which has just been read, and as illustrating the value of the process which has been shown, that the Solvays inform me they are transporting ammoniacal liquor from Holland to Marseilles in tank cars, and are using it in their process for making a cheaper alkali. That demand has advanced, to some extent, the value of ammoniacal liquor on the Continent; and the increase has been very considerable in England, Ireland, and Scotland during the past year, because of the other purposes for which it is used—mainly the making of sulphate of ammonia for fertilizing purposes. A demand exists for every pound which can be produced. Yet here in the United States perhaps not over 30 gas companies, out of 700 or 800, received anything for their ammoniacal liquor. Even our friend Mr. Pratt, of Jamaica Plain, would be able to reduce his gas below $2.50 if he utilized his ammoniacal liquor, converting it, as he could economically with his present carbonization, into sulphate of ammonia, and realizing at its present average price (4½ cents per pound), for 25 pounds out of each ton of coal, something in the neighborhood of $2,000 per annum. Were he to do this, he would have a still stronger claim upon the moral "support of the community." [Laughter.] But I must not occupy more of your time. I wish I had the scientific knowledge to which your President has so complimentarily referred, so as to be able to understand fully the process which has been presented by Mr. Fogarty. I can only urge upon every one carbonizing even 500 tons of coal per annum the great importance of saving the ammoniacal liquor, and making it valuable by proper concentration. I could read you many interesting extracts from their annual reports, showing the advance in the amount

received for the ammoniacal liquor and the sulphate of ammonia by scores of English, Scotch, and Irish gas companies—many of them being able to buy their coal with the money received from their residuals. With the fading away of the guano deposits, and the higher price of other sources of ammonia, it must be obtained from the ammoniacal liquor produced by carbonizing bituminous coal, as the water or naphtha gas processes cannot produce it.

Mr. Fogarty—Have you ever looked over Henning & Dyer's patents?

Mr. Page—I do not think I have.

Mr. Fogarty—I can show you that the Solvays have no claim whatever to the soda-ammonia process. It is free to all. The process was first developed and patented in England in 1838, by Henning and Dyer and Grey and Harris, and had been successfully tried by several manufacturers long before the Messrs. Solvay dreamed of it, while Solvay's patent was taken out in 1863. Tuerk, and also Schloesing and Rolland had taken out patents as early as 1854. Works had been started near Paris in 1855, under Schloesing and Rolland's patent, and Mickles carried on the manufacture of soda under Tuerk's patent, improved by him at the works of Lorraine, from 1865 to 1867, about which time Solvay took it up. Solvay has an absolute claim upon certain improved methods of carrying it out; that is all. The process itself is free to all. I have the patents here, and you are welcome to see them if you wish.

Mr. Page—If that process were open to the public, the wealthy chemical alkali manufacturers at Newcastle and Glasgow would have adopted it long ago.

Mr. Fogarty—It may be that the Solvays have a right to the most improved processes and methods of carrying out the process; but the process itself is absolutely open, as I can prove to you. I do not say anything that I cannot give chapter and verse for.

Mr. Greenough—I wish to ask Mr. Fogarty as to the working of a matter of detail which I do not understand. I noticed that he says in his paper, as to the second part of the process, that he proposes to pass the gas from the generator through a Siemens superheater, heated to as high a temperature as can be practically done, by the combustion of a part of the generator gas itself. Do you mean to burn a part of the gas in the chamber, and heat the rest of it at the same time?

Mr. Fogarty—I mean that the superheater is double, and that while you are heating one side of it by the combustion of part of your generator gas, another portion of the same gas is being superheated in the other side of the generator, the operations of both sides of which are reversed from time to time.

Mr. Greenough—Do you burn half of it?

Mr. Fogarty—I expect that it will take half of the generator gas to do the work.

Mr. Greenough—Can you pass the other half unconsumed through the generator?

Mr. Fogarty—Certainly.

On motion of Mr. Harbison the thanks of the Association were tendered to Mr. Fogarty for his carefully prepared and comprehensive discussion of the new process of manufacturing gas and residual products.

The Association then listened to the reading of a paper entitled "The Manufacture of Gas from Coals and from Materials other than Coals," by Mr. Augustus L. Allen, as follows:

THE MANUFACTURE OF GAS FROM COALS AND FROM MATERIALS OTHER THAN COALS.

The subject of my remarks will be "The Manufacture of Gas from Coals and from Materials Other than Coals."

Gas is usually described as a permanently elastic fluid, under the ordinary conditions of temperature and pressure. But gas, merely as an elastic fluid, differs greatly from gas properly prepared for illuminating purposes. The veriest tramp in the land can, by fire, separate the gas-forming materials in nature; but to separate them and then gather them up again and unite them in such forms and proportions as will render them available for the purposes of life, will require energy, practical experience, and scientific skill.

The possibility of producing illuminating gas from coals was discovered nearly 200 years ago; but no practical results followed for nearly 100 years afterward. Even after William Murdoch, Thomas Clegg, and others had demonstrated its possibility and practicability for public and private uses, they met with the greatest hostility and most determined opposition from scientists, artisans, and capitalists. The elder Professor Silliman, of Yale College—a man of acknowledged ability and great scientific attainments—after he had examined the process of manufacture (the washing and purification of the gas, the manner of its delivery, and the light produced), publicly expressed his opinion that its cost and dangerous character, and other great obstacles, would probably prevent its being generally adopted. Even after Mr. Murdoch had successfully lighted public and private buildings with gas, and had given a public illumination at Birmingham and astonished thousands of its population, who witnessed what was then called a "wonderful display of the combined effects of science and art," ignorance in reference to the subject of artificial gas, and prejudice against all encroachments upon the customs and experiences of the past, blocked the way to his success and prevented his receiving anything like an adequate compensation for his indomitable energy and scientific skill.

For 25 years after the feasibility and practicability of producing illuminating gas from coals for public and private use had been, as we would think, fully demonstrated in almost the identical manner in which it is produced to-day under the old process, insurance companies refused to insure buildings lighted with gas, and manufacturers refused to expend money to adapt their machinery for making anything connected with such a "foolish and dangerous a thing as gas." Ignorance and prejudice greatly delayed the success which its early advocates anticipated.

But, notwithstanding all objections and opposition, gas has been generally adopted for public and private use, and by its light may be traced the onward march of civilization through the world.

But history repeats itself. Human nature is the same to-day that it was a hundred years ago; and prejudice against any radical change in gas making is as strong now as it was then against gas at all. The object, however, of this Association is, by the aid of science and practical experience, to clear the way of all obstacles for the demonstration of the highest possibilities of this great industry, the product of which has become a public and private necessity.

The chemistry of gas manufacture is an important subject, and merits the attention of every gas engineer and superintendent. The two principal forces at his command in the retort house are heat and cold, or expansion and contraction. They work by fixed laws, and with mighty force, which cannot be ignored, but which may be governed and controlled by intelligence and skill.

Coals, and petroleum and its products, are the materials commonly used in the manufacture of illuminating gas. There are two general divisions of coals—viz., hard and soft, or anthracite and bituminous. Anthracite was undoubtedly produced by the application of great pressure and high temperature, and may be considered as the coke of bituminous coals. The petroleum now so abundantly found no doubt resulted from this process of distillation, and was stored up in immense reservoirs beneath our feet by an all-wise Providence, who wondrously prepared these materials and kept them through long ages for the coming wants of man.

Illuminating gas is composed of nearly 100 simple gases. But it is sufficient at present to say that it is composed principally of two elements—viz., the illuminants, as the hydrocarbons and olefiant gas; and the non-illuminants, as hydrogen, carbonic oxide, and marsh gas. These non-illuminants are permanent gases, and indispensable for the proper utilization of the illuminants.

Evidently there must be some relative proportion between these two elements. To ascertain these proportions and produce the proper combinations is the work of the gas manufacturer.

All the chemical changes in the materials used are produced by heat and cold. These are antagonistic to each other, the one being repulsive and the other attractive; and upon these will depend all the various combinations that will be formed from the elements subjected to their influence. And this exertion of chemical force, or affinity, is distinguished from all other species of combinations by the remarkable circumstance that, when bodies unite chemically, they do so in certain fixed and invariable proportions. Two elements may unite in several proportions, but these will bear a very simple relation to each other, while each variation will produce a distinct compound which frequently bears no resemblance to the others. Thus, phosphorus, a neutral wax-like, highly combustible, solid, insoluble in water, and oxygen (a colorless, invisible gas), by their chemical union generate sulphurous acid, a white solid, soluble in water, intensely acid, and incombustible—a body, in fact, in which the characteristics of its primary elements are entirely lost. Thus water, the great antagonist of fire, is itself composed of the most inflammable substances in nature—viz, hydrogen and oxygen.

Carbon is a solid; it cannot be divided, and is therefore called a simple gas. It is well known under the form of diamond, charcoal, lampblack, and coke. It is not gas, but has the capacity of combining with and assuming the form of gas. Its particles emit light—not by actually undergoing combustion, but by being heated to incandescence, and suspended for an instant in the flame before the particles came in contact with atmospheric oxygen. Carbon may unite with oxygen in two proportions, and form very different compounds—viz., carbonic oxide and carbonic acid. The first is a colorless, inodorous gas, composed of 1 equivalent of carbon and 1 equivalent of oxygen (or, by weight, 12 parts of carbon and 16 of oxygen). It is inflammable, and under favorable circumstances burns with great calorific intensity, and, with hydrogen, forms the basis or substratum for illuminating gas. While carbonic acid, which is composed of 1 equivalent of carbon and 2 equivalents of oxygen (or 12 parts of carbon and 32 of oxygen), is pungent, acidulous,

and is not inflammable, and cannot support combustion. The presence of even 1 per cent. will diminish the illuminating power of ordinary coal gas 5 per cent. It is, of course, an impurity in gas. Carbonic oxide is formed at high heats, carbonic acid at low heats; and they differ materially in their properties.

Ammonia, which is injurious to the eye, and is an impurity in gas, is formed when 1 equivalent of nitrogen and 3 equivalents of hydrogen unite over a red heat.

Sulphureted hydrogen, the fœtid odor of which is very nauseating, and is an impurity is gas, is composed of 1 equivalent of sulphur and 1 equivalent of hydrogen.

The above combinations, and many others, are formed at different temperatures. All the impurities in gas are formed by low or changeable heats. It is evident, therefore, that the chemical action of these two forces, cold and heat, is of the greatest importance to the gas manufacturer, and that he ought well to understand not only how, effectually and economically, to break up into fragments the substances upon which he is working, and to collect therefrom those elements desirable in illuminating gas, but also how to prevent those combinations which will prove a useless waste of materials, are positively offensive and injurious, and must be removed as far as is possible, even at great expense.

There are two general systems for the production of illuminating gas, which, for brevity's sake, I will call the old and the new, or the coal gas and the water gas processes. In speaking of water gas, I desire to be understood as referring to the "Allen-Harris, or American hydrocarbon process," because I shall be able to speak from personal and practical experience, and the records of our works at Poughkeepsie, N. Y.—where for seven years past the Citizens' Gas Company has been demonstrating certain scientific priciples which underlie the manufacture of gas for lighting and heating purposes; and I shall have occasion to refer to the exhaustive and scientific report made upon this water gas process by those eminent gas experts, Professor B. Silliman, of Yale College, and Professor H. Wurtz, then of Hoboken, N. J., in proof of facts and principles relating to the manufacture of gas under both processes.

The coal gas process has been in active operation for 70 years past, and for 50 years has had almost unlimited control of money, power, energy, scientific skill, and practical experience; every circumstance in nature seemed to contribute to give this process greater advantages than any other industry ever possessed. Wherever located it had a monopoly of the business; because gas can neither be imported nor exported, but must be made where consumed. We ought, therefore, by this time, to have presented to us the most conclusive evidence that this process is founded upon scientific principles, and worked according to chemical laws; and that the highest possibilities that the manufacture of illuminating gas from coals is capable of realizing has been attained. But, on the contrary, the volumes which have been written, and the discussions from year to year before this Association, and the individual experiences of every member here, bear witness that practical results are by no means satisfactory; and it is evident that the growing conviction among intelligent gas men is that, by the present treatment of coals, the gas produced and the illuminating value obtained fall astonishingly below the theoretical requirements of chemistry.

Dr. Gesner, in his work on coal and petroleum, says: "It is very singular that, with the ordinary process for making illuminating gas from coals, we never obtain any rich gas, whether the yield be large or small. I am certain that the system is radically wrong."

Mr. William Farmer, of New York, who is known to many of you, and may certainly be quoted as a friend of the old process, referring to Dr. Gesner's records, said: "I fully indorse his words; I am certain that the present system is radically wrong."

Major Dresser, the intelligent and popular editor of the American Gas Light Journal, who has had much better opportunities for forming correct opinions in gas matters than many, and perhaps than any of us, editorially said in substance, not long since, that the old coal gas process had very little of science or common sense to recommend it, and that it would not be long before many of its present advocates will be ashamed of their records (?) I fully agree with Major Dresser in his brief summary of the merits of the old process, and, deeply sympathizing with some here who are no doubt hoping for a posthumous reputation as gas engineers, I desire to call their attention to certain stubborn facts which at present stand in the way of their success, and to direct them, by a much surer road, to the goal of their laudable ambition.

I need not recount the difficulties which you have to contend with under the old process. They are spread out and described in every possible way in the literature of gas making.

Mr. Forstall, of New Orleans, in a carefully prepared paper read before this Association, among other things stated that he had 1,605 stoppages of his stand and dip pipes in 90 days from 12 benches. This, of course, was caused by the loss of his best and most volatile carbons.

Mr. F. C. Sherman, of New Haven, stated before the New England Association of Gas Engineers that "the loss of time, fuel, and repairs occasioned by the removal of carbon (from the retorts) is an important item in our manufacture. But, from observation, I am satisfied that some of us can improve our present methods and apparatus for the removal and prevention of carbon."

Proof is at hand of many other objectionable features, which show an entire absence of scientific principles from the whole system, and that it is "radically wrong." I think that this will appear from the results of the best workings under it, with all the improvements and experiences of the last 50 years.

1st. What amount of gas-producing elements do ordinary bituminous coals contain?

2d. What are the component parts of what is called good illuminating coal gas, and what amount is obtained from these coals under the most favorable circumstances by the old process?

3d. What ought to be and what has been obtained from bituminous coals and oil, and their products respectively?

I have time merely to call your attention to certain facts relating to the above questions. It is stated, with sufficient authority, that the gases contained in one ton or 2,240 pounds of ordinary bituminous coal are—

Total illuminants.....	55,419 cubic feet.
Total non-illuminants. ...	43,893 "
	99,312 cubic feet.

Mr. Charles Hunt, M.I.C.E., read a paper before the Gas Institute, at Birmingham, England, in June last, in which he stated that the ordinary coals, to which he referred, contain 65,000 cubic feet per ton of 16-candle gas (sp. gr., say, 450).

I assume that he is respectable authority for what he says, from the fact of his appearing before a Literary Institute in Birmingham, and that his paper was not only published in England, but was deemed of sufficient importance to be republished in our own American Gas Light Journal.

I think that Prof. Chandler gives the component parts of bituminous coals as follows:

Carbon	81.41
Hydrogen.....	5.53
Oxygen.....	7.89
Nitrogen	2.05
Sulphur.....	1.05
Ash	2.07
	100.00

Anthracites do not differ materially from the above. The following are the component parts of what is called good illuminating coal gas from Penn and Westmoreland coal, with 6 per cent. of cannel:

Hydrogen.....	39.10
Carbonic oxide	6.12
Marsh gas.....	47.57
Illuminants	6.90
	100.00

These proportions differ not only in different works, but from day to day in the same works, because the various changes in the temperature of the retorts produce different combinations of the elements forming the compound. There is a remarkable change in the proportions of the elements in the coal before carbonization, and of the products.

The coal contains 81 per cent. of carbon. The gas produced less than 7 per cent. It is admitted that 45 per cent. of these carbons might be volatilized and utilized for gas making. What becomes of the balance? I answer, they are wasted in forming incrustations in the retorts, naphtha, tar, lime, soot, and impurities in the gas, for want of a substratum or permanent gas to unite with and carry them off the moment they become volatilized. When your heats are low, you are distilling hydrocarbons greatly in excess of what the non-illuminants, then being produced, can absorb; and when your heats are high, the liquid hydrocarbons and gaseous compounds of high illuminating power are more or less decomposed and converted into carbon, solid soot, marsh gas, etc. In fact, four-fifths of the luminants contained in the coal are destroyed to obtain the necessary non-illuminant portion of the gas. You never have, and never can, under the old process, simultaneously produce illuminants and non-illuminants in proper proportions for a good high candle gas, or realize from gas coals one-quarter of what, with proper treatment, they are capable of producing.

I do not think that anyone will claim that the average yield, under the old process, from ordinary caking coals, exceeds 10,500 cubic feet of 16-candle gas, sp. gr. about 420. To show that I have rather overestimated the average yield, I refer to a report made by Mr. Greenough, I think, at a meeting of the New England Association of Gas Engineers, as published in the

Gas Light Journal, of certain tests made in the Boston Gas Light Company's works, with Penn coal—viz., 12 clay retorts were charged with 200 pounds each, equal to 2,400 pounds; duration, 4 hours each charge. First test produced 12,349 cubic feet; second test, 12,270 cubic feet. The coal was said to be in good condition, and no doubt the retorts also. It was stated that during the latter part of the charge the gas was almost without illuminating power. The remark was made, "I do not say that we could produce 12,000 feet per 2,400 pounds coal of 16 candles." Our mutual friend, Col. Armington, denounced the idea "that 12,000 or 10,500 feet of 17 or 19 candle gas can be extracted from coal." He said we all know that such stories "are not true; it will not average 11 candles." It was understood that the test yields were exceptional, and made under the most favorable circumstances.

It appears, from the semi-annual report of the London Gas Light and Coke Company, for the six months ending June 30, 1882, that from 643,068 tons of English coals the average of gas made was 10,346 cubic feet per ton. The average of gas sold was 9,668 cubic feet per ton.

The Paris Gas Light Company, with its immense monopoly and unlimited means, shows no better results.

Professor Love, the expert gas examiner in New York city, reported the specific gravity of the gas of the Manhattan Company at 424, and the Harlem Company at 413.

I believe that I may safely state that the highest average yield per ton of 2,240 pounds of bituminous coal does not exceed 10,500 cubic feet of 16-candle gas, sp. gr. 420, by the ordinary process of destructive distillation.

Now, 2,240 pounds of Penn coal, by proper distillation will yield 575 pounds of oil—equal to 82 gallons. This coal oil naphtha is much richer in quality than petroleum naphtha, and will produce 80 feet per gallon—equal to 6,560 feet of 70 candle gas. This will equal 28,325 cubic feet of 16-candle gas. But this rich gas is not suitable for ordinary purposes; it requires a diluent. If, then, a diluent can be furnished that will not only increase the volume of gas, but will increase it in much greater ratio than it reduces the candle power, it is evident that the above 28,325 cubic feet per ton can be increased.

Hydrogen and carbonic oxide, or "water gas," form the best basis or substratum for illuminating gas.

1st. They are permanent gases, and form a valuable medium for the solution of the vapors of the hydrocarbons, and enable us to convert an additional quantity of illuminating materials into the gaseous form, which they retain permanently.

2d. They produce the highest calorific intensity of any of the gases; and, inasmuch as the luminosity of gas is increased by the intensity of the flame, these gases are superior to others as a diluent.

3d. Hydrogen consumes only one-half its own volume of oxygen, and generates no carbonic acid.

4th. Carbonic oxide consumes only one-half its own volume, and generates its own volume of carbonic acid.

5th And lastly, because light carbureted hydrogen, or marsh gas (the principal basis of coal gas), consumes twice its own volume of oxygen, and generates its own volume of carbonic acid. It is a much more dangerous element in gas than the others.

Some have spent a good deal of time to prove the waste of energy in the production of water gas, and state that one cubic foot of coal gas is equal in units of heat to 2.20 cubic feet of water gas. Their conclusions have invariably been drawn from false premises. A little practical experience would prevent the publication of many such erroneous statements.

Professors Silliman and Wurtz, in their report before referred to, state that the gas made under our process contains 70 per cent. greater calorific intensity than coal gas. They made a good many practical tests with both kinds of gas, and came to their conclusions from actual facts. The whiteness of the flame of our gas, the entire satisfaction given in running a 4-horse engine for nearly three years, and for heating and cooking purposes, afford abundant proof of the truth of their statement.

The calorific intensity produced by carbonic oxide differs according to the favorable or unfavorable circumstances attending its combustion.

Now, hydrogen and carbonic oxide are called non-illuminants. The investigations made by Bunsen and others on the nature and composition of gases evolved from the Besemer converter during the blow, show that—

From the start	2 minutes	to 14 minutes.
There was carbonic acid.....	10.71 pr. ct.	to 1.34 pr. ct.
Carbonic oxide	none	to 31.11 pr. ct.
No hydrocarbons.		

They said that the large percentage of carbonic oxide at the latter stage of the blow explained why the flame had become so much more luminous; and that, as no hydrocarbons were present, it would appear that carbonic oxide does produce luminosity.

Deville says that the increased luminosity of flame is due solely to the increase of temperature, and explains the reason of the great brilliancy of the flame compared with that of carbonic oxide burning at a low temperature.

In combination with hydrogen, carbonic oxide is a most effective element in gas for illuminating purposes, as the practical results of seven years' workings of our process at Poughkeepsie have fully demonstrated.

But the question still remains, What progress has been made under the Allen-Harris process in demonstrating the possibilities of coal and oil for the production of good illuminating gas?

Mr. G. W. Harris, the engineer and one of the patentees of our process, has, in small works and under unfavorable circumstances, produced at the rate of 40,000 cubic feet of 16-candle gas per ton of bituminous coal—showing what can be done by having a full supply of hydrogen and carbonic oxide present to absorb and carry off the carbons as they become volatilized.

Our workings at Poughkeepsie have been made for the most part with petroleum naphtha, and our limited consumption has prevented us from presenting results anything like as favorable as many, and perhaps most of you, could have shown from works with a consumption large enough to have enabled you, for convenience, facility, and economy, to use certain proportions of caking coal, rich bituminous coal, and oil, in connection.

Our experience, and the improvements that we are making, convince us that we are only on the eve of what may be accomplished under our system of continuous workings and uniform heats, by which we make illuminating gas so free from impurities that we have purified an average of over 113,000 cubic feet of gas per bushel of slaked lime. Mr. Harris, who has charge of his own works at Rondout and Kingston, with the same process, changes his purifying boxes about once in four weeks, averaging about 35,000 cubic feet per bushel of lime.

We hold the true system to be to manufacture illuminating gas without wasting materials in making impurities which injure the gas and cause great trouble and expense.

For six months past we have made all the gas required with two benches of three retorts each, producing as high as 82,800 feet of over 20-candle gas in 24 hours, and then slacking up because the holder was full—often throwing away thousands of feet of hydrogen for want of consumption and storage room.

Our averages for the six months to October 1st were, per 1,000 feet—

Anthracite coal in hydrogen retorts, 17.96 pounds, at $4.37 per ton.
Naphtha, 4.17 gals., at 4½ cents.
Candles, 20.51; sp. gr., about, 650.

Cost in holder, 40.2 cents—under all the disadvantages before referred to.

Taking the same calculations before made of 82 gals. oil per ton of coal, and 80 cubic feet per gal. of 70 candles, our average yield will equal 30,725 cubic feet of 16 candles per ton of Penn coal; which I believe is the highest practical showing of its possibilities for producing good illuminating gas that has ever been made.

But I am told that we have no residuals, and that they are valuable, and defray a great portion of the expense of manufacture.

These residuals are the wastings under the old process. Is there another industry in the world in which the waste of material is depended upon for profits of the business? But while making profits out of the residuals, what are you doing to satisfy your consumers? They demand the best light, and very soon will be satisfied with nothing less. The time has gone by for the public to be satisfied with traveling on mixed freight and passenger accommodation trains. The cost per mile has very little to do with it. Quick time and good accommodations are demanded. And so it will be *the best gas* or *electric light;* and you must calculate on running different works for illuminating gas and residuals.

Instead of making efforts to meet these demands, many have spent their time in decrying water gas, and charge that it is dangerous to life and health on account of the carbonic oxide that it contains.

I said at first that I speak only for the gas produced under our process, and again quote from Professors Silliman and Wurtz's report. They say, on page 117, under the "Fourth" important conclusion: "The gas obtained by this process is remarkably easy of purification, uniform in quality, and greatly superior to gas obtained by the old process in its ability to withstand low temperatures without sensible loss in illuminating power." And, "Tenth, In entire variance with popular belief, our analyses prove that a compound hydrocarbon gas consumes much less atmospheric oxygen, and vitiates a given volume of air to a much less degree than ordinary gas of equal illuminating power." This has been practically demonstrated in three several cases in Poughkeepsie within the last three years.

It so happens that every hotel in the city except one is supplied with our gas. In each instance referred to the persons on retiring blew out the light, leaving the stop open, and inhaled the gas all night. One of them, inhaling it for 12 hours before being discovered, was found insensible at 11 o'clock Sabbath morning, but immediately revived on being exposed to the air; and that evening took tea at the public table of the hotel, and the next morning commenced his studies at Eastman College. None of the three experienced

any ill effects from their exposure. There is probably not a case on record where any person survived after such an exposure to the effects of coal gas. The cases were all published in our daily papers at the time, and the facts are easily proved.

We have supplied the Hudson River New York State Hospital, and its 300 invalids and lunatics, with gas for five years past. The superintendent, Dr. J. M. Cleaveland, and family, the resident physicians, and many employees reside there, and about 500 burners are used nightly—many of them almost continuously. There has never been a complaint of any kind against the character or quality of the gas; but, on the other hand, there has been universal commendation. St. Barnabas Hospital, also often crowded with invalids, has been supplied by us for years without a single complaint having ever been made.

So, also, Professor Cook's Collegiate Institute for young ladies, Professor Warring's Military Institute, Prof. Bisbee's Military Academy, and other educational institutions filled with boarding scholars; also, many hotels and private boarding houses, where greater exposures than in private families would be likely to subject the inmates to any deleterious effects of this gas that might exist; but there has been no complaint in relation thereto.

On the other hand Dr. Le Roy C. Cooley, the eminent professor of chemistry in Vassar College, at Poughkeepsie, who has used our gas in his family for nearly seven years, has certified that, "I have used your gas with steady satisfaction, and that, while acquainted with its composition, I am still using it without the slightest apprehension arising from the presence of any poisonous constituents."

The men in our works have been for seven years exposed in every possible way to the effects of this gas; but not one has ever exhibited any serious effects therefrom.

Professor Adolph Wurtz, Member l'Institut, etc., positively denies that water gas has even been prohibited in Paris (see Report of Board of Health to the Board of Aldermen of New York, April 15, 1881) but confirms the statement "that the product or effects of burning water gas are less objectionable to a marked extent than from coal gas." M. G. Tourdes, in an article upon the anæsthetic action of carbonic oxide (see Comptes Rendus, 1857, Vol. 44, p. 96) says, "The two fundamental facts are the *harmlessness* of the gas and its anæsthetic action." Dr. M. Ozanam is probably one of the best authorities on the properties and nature of gases. In an article on the anæsthetic action of gases (published in the Archives Generales de Medecine, Paris, 1857, 5th Series, Vol. 9, p. 159) he says, under the head of "action of carbonic oxide on man," "Can carbonic oxide be inhaled by man? Everything points to the belief that it can. * * The 25 experiments which we made, and of which several have been repeated upon the same animals, show that the use of this gas is not as dangerous as was formerly believed, since we have but one case of death among animals so delicate as rabbits."

Leblanc, Devergie and others have safely used it as an anæsthetic upon men and the lower animals.

Adolph Wurtz states that he has used it several times upon the same animals without a single fatal result.

I think that the only legitimate conclusion which can be drawn from the whole matter is that, even admitting that carbonic oxide alone, in its concentrated form, is poisonous, yet, in combination with the other elements constituting illuminating gas under our process, its nature is so changed that the entire product is less deleterious to life and health than coal gas.

Discussion.

Mr. Allen—I desire to add that the President of our Association, through misinformation, published an article in which he stated that the Citizens Gas Company of Poughkeepsie had never paid any dividends. I know that he was misinformed with regard to it, and that he will correct it when I say that in seven and a-half years we have paid 14 dividends. He has been misinformed by some person who was evil-minded, or who did not know the facts.

The President—How much was the dividend?

Mr. Allen—On $300,000 worth of capital and bonds we have paid an average of over five per cent. per annum. We have been laboring under many disadvantages. Even in running only two benches during the summer we have lost thousands of feet of hydrogen gas for want of consumption and storage room. You can run to the full capacity of your works, but we lose heat, labor, and time. We have increased our consumption considerably of late, and can make for the last six months the most favorable report we have ever been able to make of our workings. With only two benches of three retorts each, we have run up to 82,800 feet of gas of 20.51 candle power. Then we slacked up because our gasholder was full. If we had the consumption which many of you have, we could show much better results than are possible at present. In manufacturing only a small amount, we cannot show the same results as those can who manufacture on a large scale.

The President—At what cost per thousand feet can you put the gas into the holder?

Mr. Allen—For the last six months we have had 20.51 candle power gas delivered in the holder at 40 cents, and we pay higher for oil and coal than many of you, and we do not use half the capacity of our works for making gas, for want of consumption.

Mr. Forstall—What do you pay for oil and coal in Poughkeepsie?

Mr. Allen—We have paid for coal, during most of the time, $4.50. The anthracite has averaged $4.32, and oil 4½ cents.

Mr. Forstall—Would you recommend water gas in a city where oil costs 8 cents per gallon, and anthracite coal $8 per ton, and where good bituminous coal can be got for $4 per ton?

Mr. Allen—I would recommend the use of bituminous coal, when cheaper than oil, using caking coal enough to run the works with, to make the coke required, and bituminous coal of the richest kind, yielding 20,000 or 30,000 feet per ton, and thereby saving freight, storage, and manual labor, and making hydrogen sufficient to take up all the volatile carbons as they become volatilized. Practical experience would show how much of each kind of coal it would be most advisable to use. My own idea is that I would run in a half gallon or a gallon of oil from time to time, so as to secure a uniform quality of gas.

Mr. Forstall—What can you make 18-candle gas for by your process, with anthracite coal at $8 per ton and oil at 8 cents per gallon?

Mr. Allen—I think that oil is cheaper at 10 cents per gallon than using bituminous coal, unless you get very rich bituminous coal, where you can make 20,000 or 25,000 feet per ton, and thus save labor and freight. You can use a barrel of oil without losing 1 per cent. by our process.

Mr. Forstall—My question is, what your gas would cost per thousand feet of 18-candle power, with oil at 8 cents per gallon and anthracite coal at $8 per ton.

Mr. Allen—That would depend upon how much you made.

Mr. Forstall—Assume a million feet per day.

Mr. Allen—We pay $4.32 on the average for anthracite coal, and 4½ cents per gallon for oil; and it has averaged us just 40 cents.

Mr. Forstall—That is 80 cents per thousand feet, without counting the extra labor.

Mr. Allen—It is 40 cents, including the labor, with us.

Mr. Forstall—I assume the cost at 8 cents for oil and $8 for coal.

Mr. Allen—But you are talking about a million feet. We have averaged 4.17 gallons per thousand feet when using petroleum naphtha, which is not as rich as the naphtha from bituminous coal. With naphtha from bituminous coal we would not use over 4 gallons.

Mr. Forstall—Four gallons at 8 cents would be 32 cents.

Mr. Allen—Yes

Mr. Forstall—And $8 for anthracite would be how much?

Mr. Allen—About 17 pounds of anthracite per 1,000 feet for the production of the water gas. You can estimate the cost.

Mr. Pearson—Is that all the coal you use?

Mr. Allen—That is all we use for the production of our water gas. In answering that question I desire to say that it has cost us 17 pounds of coal in the retorts and 58 pounds in the furnaces per thousand feet of perfected gas; but, as I have said, we have lost thousands of feet of gas for want of consumption and storage room for it. The heat was wasted, and we therefore wasted coal in the retorts and furnaces. It is therefore hardly fair to compare our small works, producing 75,000 feet per day, with those producing a million.

Mr. Forstall—I can make coal gas in the city of New Orleans for 35 cents per thousand feet, of 17-candle power. What could you make your water gas of that candle power for if you paid the same prices for oil and coal? If you can answer that question I can determine whether it would pay us to change our works.

Mr. Allen—Let me say, in answer to that, that you do not allow for your extra expenses in keeping the retorts clean, and in purifying the gas.

Mr. Forstall—That is all included in that price. The gas is put into the holders, and expense for purification, etc., paid, at that price.

Mr. Allen—Perhaps you can make the calculation as well as I can, taking the basis which I have given you. I give you what we can produce the gas for, under all the disadvantages which I have stated.

Mr. Forstall—I take it that the water gas would cost just twice as much under the circumstances.

Mr. Allen—It would be twice as good when you got it; but it would not cost as much if you used bituminous coal under our process.

Mr. Pearson—Is 58 pounds of coal the entire quantity of coal that you use in manufacturing a thousand feet of gas?

Mr. Allen—No; I stated that we used 17 pounds in the retorts (it is 17.58 exactly), and 58 pounds in the furnaces.

Mr. Pearson—Does that include raising the steam?

Mr. Allen—That includes everything; but my own opinion is that under the ordinary circumstances in which you would work it would not take over 50 pounds of coal for the whole.

Mr. Harbison—What is the price of gas in Poughkeepsie?

Mr. Allen—It is $1.75.

Mr. Harbison—That is, it costs you 40 cents in the holder, you sell it at $1.75, and make an average of 5 per cent. profit on your capital stock.

Mr. Allen—You can figure that for yourself. I think we have done pretty well under all the unfavorable circumstances.

Mr. Harbison—A reference was made in your paper to a report on the merits of the gas, made by Professors Silliman and Wurtz. That report was made how long ago?

Mr. Allen—It was made ten years ago. I spoke of that report for the purpose of showing that we had more than carried out, in practice, the theoretical conclusions which they published at that time. It shows the remarkable knowledge of the subject which they possessed when they made the report ten years ago. We have practically gone beyond what they stated at that time could be done under our process.

Mr. Harbison—The minds of some of the gentlemen present are favorably impressed with the fact that such distinguished gentlemen as Professors Silliman and Wurtz have given evidence favorable to this gas; and if they have recommended it, as stated in your paper, and as the report shows, the question naturally arises, why would it not be worth while to try its manufacture on the strength of the recommendation of such eminent gentlemen, enforced as that recommendation is by your experience of seven or more years of manufacture in Poughkeepsie? If I am correctly informed, one gas company in Connecticut, on the strength of that report, bought the right to use your process, and did introduce it and work it experimentally for some time in an adjoining town. They then connected the mains of those works with the mains of the works in the city, and tried the new process in the city works for some considerable time. After fully, in a practical way, demonstrating to their own satisfaction the worthlessness of the process, they gave it up altogether, and have not used it at all since that time—some eight or ten years since.

Mr. Allen—The fact of failure in other places seems to be a sort of capital that is constantly used against us. Supposing we failed seven years ago; is that any proof against the process when we are now able to show the result of seven years of continuous working? Has the question of a failure seven or ten years ago anything to do with the success of the process to-day? I think our practical experience to-day shows that our process is all that we ever claimed for it; and, as I have said in my paper, we are just on the eve of showing what can be done under favorable circumstances. With regard to the introduction of the process in New Haven, to which you refer, I will state that they tried it in the little works at Fair Haven, with only two benches. They tested it there for five months, and were so well satisfied with it that the president of the company, Judge Boardman, purchased the right. He asked if we had any objection to letting their superintendent run it for a week without Mr. Harris being there. We said that we had not; and they ran it three weeks and were satisfied with it. They used the process in four of the old benches in the New Haven works through the following winter, and Judge Boardman said they made the only extra dividends from those four benches that they had ever made at the works; and they made it by the use of our process. So well satisfied were they with it, that they ordered Mr. Cox to put up sixteen new benches for using our process. It was some considerable time before he could get the work done. We were, of course, very anxious about it, but had no means of hurrying it. When his block of benches was nearly completed, he ordered forty superheaters to be made. We gave him the dimensions for them; but he thought to have them a little better, and so ordered them to be made one inch larger each way. For some reason the order was misunderstood, and they were made one inch smaller each way. He came to see us about them, and we were disappointed and did not recommend his using them. Others could not be procured in time, and so the benches had to be fitted up in the old way. Judge Boardman became a great friend of our process, but he soon died; and we have no one to take the same interest that he did. That was the reason for that failure. We did not commence with the intention of running in opposition to the old gas companies, but to show an improvement in making gas. We built our own works in Poughkeepsie in order to demonstrate that fact. Some gas men said to run it a year, or two or three years, and see what it would do. We have now run it for seven years, and are doing better to-day than ever before. I claim that our experience shows that the principles of the process are scientific, and that it is the best and most scientific process in use. We hold to making a pure gas in the retorts. The impurities are all caused by the up and down heats. Every change of temperature changes the combinations of the gas-making materials. You have many advantages above what we have. Why do you not try to see whether a pure illuminating gas cannot be made in the retorts? See how pure it can be made, and how you can utilize the oils which the coal contains, not wasting three-quarters of them, as you now do. A great deal has been said and written about waste of energy in making water gas. We can make it for 11 cents per thousand feet in any quantity. There is not much chance for waste of energy here.

Mr. Harbison—What is your consumption of gas in Poughkeepsie?

Mr. Allen—We made a little over 24,000,000 feet last year. In September we sent out as high as 81,000. That is the highest we have ever sent out in September.

Mr. Harbison—Do you know what the gas costs delivered to the consumers, and the money for it in the bank? You have stated what it costs in the holder; what can you say as to the expenses for distribution, etc.? Are they as great as the cost of the gas in the holder?

Mr. Allen—I should think so, or greater.

Mr. Harbison—Then that would leave you about 95 cents per thousand, which, on 24,000,000 feet, would make about $23,000.

Mr. Allen—Yes.

Mr. Harbison—Then it would take about 50 cents per thousand to pay the dividends. What I am trying to arrive at is whether, by introducing this process, or any other water gas process, I can reduce the cost of the gas to the consumers, and still pay the dividend to the stockholders. In seeking for information with regard to these processes, I have inquired of people who have used them, and who know something about them. Hence I sought for information in New Haven, where I was referred for information by the representatives of your process. The president of the New Haven Company told me that it had cost his company over $15,000 in cash to experiment with your process, and that they had thrown it out as being utterly worthless.

Mr. Allen—He was not there when Judge Boardman tried it? The books of the company at that time do not show that our process was a failure, or worthless, but a perfect success. Judge Boardman's death was to us a great loss.

Mr. Harbison—That was the information I got from him, and I was satisfied with it.

Mr. Allen—You must not go to failures for information, but go where we have made it a success by practically working the process. At Poughkeepsie was the first time we ever had control of a gas works. It is not a fair test to see how little can be done where others control the works.

Mr. Harbison—I went to New Haven to investigate it at the request of a company who owned your patent rights, and at the request of Professor Silliman. I visited Fair Haven while the experiment was going on there, and I saw the books, which represented 6.56 as the yield. In the office of your company, in Beekman street, I was informed that that was a low average of the results obtained by your process. In searching for further information I inquired of Mr. Trowbridge, the president of the company, to whom I was referred; and that was the information that I got in regard to it. I was told at Fair Haven that it was 6.56, and the foreman showed me the figures on the books.

Mr. Allen—At that time the New Haven works did not average 4 feet, and 6.56 was considered good; but we did produce over 8 feet. We have made great improvements since then.

Mr. Harbison—I was in hopes your would. But, with all the improvements which have been made since then under your manipulation, why is it that, although the selling price to consumers is nearly as much as I am selling gas for in Hartford, the percentage of earnings by this improved process is not so great as mine?

Mr. Allen—Are you selling for $1.75 in Hartford?

Mr. Harbison—I am selling at $2.

Mr. Allen—But look at your consumption as compared with ours.

Mr. Harbison—I know what that is. It has been largely increased within three years by reducing the price of gas. The increase has been nearly 60 per cent. on the $2 per thousand feet basis. I attribute the increase to the reduction, together with the energy which has been put into the business by conducting it upon a business basis. I want to see how I can get the gas down to $1.50; I hope soon to get it down to $1.75 by my present processes.

Mr. Allen—I have a friend living in Hartford, who told me that the gas in Hartford did not begin to compare with the gas in Poughkeepsie for illuminating power. [Laughter.]

Mr. Harbison—But we have never claimed to make gas of twenty candle power. We have averaged by the photometer, for over a year, over seventeen candles, which is not very bad for the Hub of the country; and the people are entirely satisfied. Our own customers are entirely satisfied with it; and that is as good evidence as I want that the gas is good.

Mr. Allen—But I have been invited to go there by some of your people who do not appear to be perfectly satisfied.

Mr. Harbison—I should be delighted to see you; and if you can carry the quality of the gas in your eye from Hartford to Poughkeepsie I shall be glad to have you do so. What I want to get at is whether, by your process or by any other process, I can get the gas down to $1.75 any sooner than I can by my present mode of operation, with the improvements I am able to introduce. I want to get down to $1.50 as soon as my friend, Price, in Cleveland, notwithstanding he gets his coal cheaper than I do. Our running expenses in Hartford are not so high, and I expect to meet the price of coal in that way.

I know that my friend in New Haven is anxious to get as low as Hartford; but he has not reached it yet. I want to get the facts in regard to your process, and to know how I can be helped in the effort to get my gas down to $1.50.

Mr. Allen—I think, as a good engineer, you can understand this—that if you are able to produce a permanent gas which will surround your illuminants as they become volatilized, and prevent them from being burned up, as they now are, you can increase the quantity of your gas without its costing any more to make it than it does now when you are getting only one-third of your illuminants utilized, to say nothing about the stoppages of the standpipes.

Mr. Helme—Have I been rightly informed that your process has been lately put in operation at Norfolk?

Mr. Allen—It has not been put into operation yet. We sold the right there and expected it to have been put into operation before this; but circumstances were against it. They did not get the materials as soon as they expected. While the things were being sent there the president of the company (a gentleman in every respect) went to North Carolina for his health, and was brought back on a stretcher, with one leg broken and the ankle of the other sprained, and he has been very low from nervous prostration; and from that time to this no one has been able to see him on business matters. That has interrupted everything.

Mr. Helme—I knew that they recently bought your process and put up the apparatus; it surprised me when I heard that they introduced your apparatus there, and I afterward came to the conclusion that you had shown them that they could do better than they had been doing. They have tried several different processes there, and now I understand that they have purchased your process I must say that Mr. Allen holds the trump card at Norfolk. I wish to say that the difficulty with you gentlemen who advocate the making of gas from oil and water, is that you are unwilling to come down to the facts and figures by which we can get at the actual and absolute cost. Coal gas men are willing to make those to the smallest fraction of a cent, and to submit them to their friends; but we cannot get you down to that. You must admit Mr. Forstall has been unable to get from you just what we are all wanting. For the last three months I have been hunting for information of that kind for myself, for a reason not worth mentioning. I have always thought there might be some difficulty in the matter, but there is not. Circumstances alter cases—and I am satisfied that there are places in this country where you can make gas from water and oil, cheaper than you can from the cheapest coal; and there are other places where it is impossible for any oil process to compete with coal. I am a director in the Pottsville Company. When I became a director there they were making gas from bituminous coal taken from the Westmoreland mine. That coal was costing $6.50 per ton of 2,000 pounds. They were selling gas at $2.50, and were making no money, and could make no money the way things were then going. The works were not well managed. The question came up about altering them. At the first meeting of the board I said to them that it might be well before concluding to spend $12,000 or $15,000 in this experiment to see if the works, as they were, could not be better managed, and gas made at less expense for labor, etc., than was then being done. But there had been several gentlemen there to see them about making oil gas, and they had heard such flattering stories about it that they were not willing to listen to any delay. As it happened one of the Lowe agents had been there. I said, "Gentlemen, if you are determined to make this change, you had better first spend a little money in travelling, and in going about to see what has been done." They asked me where they should go. I replied that they had better first go to see Marcus Smith, at Wilkes Barre, and that he would give them all the information necessary. They went there. Soon after that we had a meeting of the board and they concluded to make a contract with a party in Philadelphia; and they put up, what at that time was said to be the best plant of that kind in the country. I forget how many months it is since they started it; but it went along pretty well, and the gas was quite as good as they had been making from coal, and perhaps better. I asked them to send me down every month a report in detail of what materials they used up, and what it cost them per thousand feet of gas. The report came along for several months in succession. It was five gallons of oil per thousand, and 56 lbs. of coal per thousand. They put down the lime at ten cents per bushel (it did not amount to much); and then there was the account for wages, etc. The statement looked right well; but I happened to go up the following month, and, in looking over the figures, I found that the 56 lbs. of coal per thousand feet was in the generator alone. Said I, "What amount of coal did you use under the boiler?" The man in charge replied, "I have not counted that." Said I, "Do you not think it is used up?" He answered, "Yes." "Well," said I, "why do you not make an account of that, and let us get at the bottom facts; let us know how much you use altogether?" This was done during the following month, and it was found to be 19 lbs., which, added to the 56 lbs., just makes the 75 lbs. And that is pretty nearly what they all use. Mr. Smith says that he gets along with a smaller quantity; but they use up about that much. This is one of the towns in which to make that kind of gas, because they get their oil at 5 cents per gallon, and they get their anthracite (steamboat) coal at $2.60 for 2240 lbs., laid down in the gas-house, and they buy nut coal for $1.60. You can strike the average there and get at the cost. They use 75 lbs. per thousand feet—that is, 56 lbs. of the high-priced coal, and 19 lbs. of the other. When we get figures of that kind we can tell just how we stand, and can then fix our eyes upon some locality where we want to operate and draw the comparison. As Mr. Forstall mentions, I have no doubt that eight cents is the price of oil in New Orleans. I know that 8½ cents is less than they can lay it down in Atlanta for. I cannot lay down in Atlanta 2000 lbs. of anthracite coal for less than $8. Lime is 25 cents per bushel; and we can purify five times as much coal gas as we can water gas with the same quantity of lime.

Mr. Allen—Can you purify 113,000 feet per bushel of lime? We have done that.

Mr. Helme—Then that is one thing in your favor. I mention this fact because we are threatened with opposition. They said they would use coke instead of anthracite coal, so I bought some coke so as to know what coke would do, and sent it to Pottsville, and asked them to use it instead of anthracite coal, and to let me know the result. I knew that coke was not as cheap to them as coal. Now let us take the other side of the account. We get as good coal as the Penn or Westmoreland coals, laid in the sheds, at $4 per 2,000 lbs. We can easily get 9,000 feet per ton. We have 20 bushels of coke left for which we have ready sale at 12 cents per bushel. We have a barrel of tar for every five tons of coal which we can also readily sell at $1.25 and $1.50. We purify from 15 to 20 thousand feet per bushel of lime, for which we pay 25 cents. Putting these together and we find that, when we give the credits for the coke and the tar, it brings the absolute cost of the coal down to $1.35 per ton; and we get 9,000 feet out of that. You will find that we are favorably located for that kind of business; and any man would be simply a fool to change and go to making oil gas under such conditions and circumstances. When you gentlemen are talking of oil you ought to bear in mind that circumstances alter cases. We get this coal from Alabama. It is a first-rate coal, and it is of recent development. Mr. Forstall is using the same. These are the facts. When coal gas men are talking they can always give the exact figures as to what they are doing. Why don't you tell us what you can do in making a million feet of gas per day. Then we could tell whether it would be to our advantage to make a change or not. It may be that you can make gas enough cheaper than we can to warrant us in buying the patent. We have no prejudice whatever against the process. What we want is to get the best gas for the least money, pay reasonable dividends on our stock, and then to give the consumers the benefit of the better gas and the lower price.

Mr. Allen—It seems to me that I have defined more clearly in figures what our gas costs us in Poughkeepsie than you have what your gas costs you in Atlanta. You have not stated what you can make a million feet in that place for. They asked me to show what we could do to make a million feet under the same circumstances as Mr. Forstall. He is an arithmetician, and can calculate it better than I can. I have stated what we are doing by the year, and have given the prices in Poughkeepsie, and yet you say that I refuse to give you facts and figures.

Mr. Helme—But you must admit that you cannot make it in New Orleans at any such price as that which Mr. Forstall is now making coal gas.

Mr. Allen—I do not know that that conclusion follows. I have expressly stated that if oil at New Orleans was higher than coal, I would recommend the use of coal, and that better and cheaper gas can be made from coal under our process than under the old process. I have stated the facts under all the disadvantages that we labor under at Poughkeepsie. I state what we are doing; you can draw the conclusion as to what we could do if we had a larger consumption. You admit that you can not make as high candle power as we do. Many of you are making gas in cities where they demand the best light, and where they would buy the best butter at 40 cents instead of taking the second quality at 20 cents. They do not ask whether you are making gas at 40 or 30 cents; they simply ask, "What is the candle power that you propose to give us?" We have made 20.51 in the last six months, and had given 20.08 for the six months before that.

The President—There is one question that I would like to ask you, Mr. Allen. You have stated that you make 5 per cent. on $300,000 as your capital and bonds?

Mr. Allen—Yes; and we paid 7 per cent. on our bonds the whole time.

The President—You sold 24,000,000 cubic feet at $1.75?

Mr. Allen—Yes.

Mr. Helme—Do you sell 24,000,000 cubic feet or make 24,000,000 cubic feet?

Mr. Allen—Our sales amounted to about 24,000,000.

The President—The difference between the amount you divided and the amount you received for gas must necessarily be the cost of production?

Mr. Allen—Yes.

The President—That leaves $27,000. Dividing that by 24 will show the cost of the gas delivered to your consumers.

Mr. Allen—Yes; but I want to say that we are running an opposition there, and are doing a great deal of work for nothing.

The President—That makes $1.12½ as the cost delivered to the consumers.

Mr. Allen—But you are overlooking one fact—that 24 millions is the quantity sold; there would have to be a larger quantity made.

The President—But, taking your own figures, is not the cost $1.12½ as delivered to the consumers?

Mr. Allen—You do not take into account that we have laid a good many miles of main out of it. We have expended at least $10,000 during the past year out of our earnings.

The President—If that is to be considered here in the representations made with regard to the cost of gas, it introduces a very uncertain element in the calculation. As companies are ordinarily conducted if they make an expenditure of $10,000 it goes to the capital account, and increases the capital to that extent. If there is an uncertain limit of expenditure on the capital account, which comes out of the profits, then you are all at sea in your calculations as to the cost of the gas.

Mr. Allen—Not in regard to the cost in the holder. The cost of delivering gas to the consumers varies of course in different places. The cost of the gas in the holder does not include any of these extra expenses.

Mr. Harbison—I do not care a farthing for information with regard to the cost in the holder, when I do not know what the percentage of loss and condensation is. What we want is the cost of the gas when the money is in the bank to pay dividends with.

Mr. Allen—I will give you that: and I think we can beat you blind on that score.

THE NEXT PLACE OF MEETING.

On motion, the Chair appointed the following-named gentlemen as a committee to report and recommend the place for holding the next annual meeting: Messrs. William Helme, John P. Harbison, John H. Cowing, Theobald Forstall, and Thomas Butterworth.

The Association then adjourned to meet the following day (October 19) at ten o'clock, A.M.

SECOND DAY—MORNING SESSION—OCTOBER 19.

The Association met at ten o'clock, A.M.

The Executive Committee presented the following additional report and recommendations—

1. That the Association direct the Secretary to proceed with the publication of Volume V. of the Proceedings, in the usual manner, printing 600 copies, the volume to comprise the Proceedings of the last and of the present annual meetings.

2. That the Secretary's salary be fixed at the usual figure ($300), and his actual expenses in attending the meeting.

On motion, the report was accepted, and the recommendations were adopted.

The special committee appointed to select the place for holding the next annual meeting made the following report—

Mr. Helme—The committee met this morning, and decided upon holding the next annual meeting in New York city; and as we have no invitation to go to New York we are at perfect freedom to exercise our own inclination as to what house we shall go to, in what way we will be entertained, and how we will entertain ourselves. We leave that matter for the Association to decide upon.

The President—Have you indicated the time?

The Secretary—The time is fixed by the Constitution as the third Wednesday in October.

On motion, the report of the committee was received and adopted.

Mr. Greenough—I move that a local Committee of Arrangements, consisting of five members, one of whom shall be the Secretary, be appointed by the Chair, and that they be authorized to make the necessary arrangements for the next annual meeting.

The motion was agreed to, and the Chair appointed the following members on said committee—

James H. Armington, James R. Floyd, George S. Page, Fred. S. Benson, and Wm. Henry White.

The committee appointed to present the names of officials for the ensuing year, made the following report—

Mr. Price—As chairman of the committee appointed to report the names of persons suitable and proper to hold the offices of this Association for the coming year, I report as follows:

President—Theobald Forstall, New Orleans, La.

Vice-Presidents—Wm. A. Stedman, Newport, R. I.; Eugene Vanderpool, Newark, N. J.; Austin C. Wood, Syracuse, N. Y.

Secretary and Treasurer—Wm. Henry White, New York.

Finance Committee—A. B. Slater, Providence, R. I.; Geo. S. Hookey, Augusta, Ga.; John Andrew, Chelsea, Mass.

Executive Committee—M. S. Greenough, Boston, Mass.; Fred. S. Benson, Brooklyn, N. Y.; Thomas Butterworth, Rockford, Ills.; Frederick W. Gates, Hamilton. Ont.; Thomas Turner, Charleston, S. C.; J. H. Rollins, Worcester, Mass.

We have made some changes in the Finance and Executive Committees, according to the requirements of the Constitution.

Mr. Harbison—I move that the report of the Committee be received, and that the Secretary be authorized and directed to cast the ballot of the Association for the persons recommended by the Committee as officers for the ensuing year.

The motion was agreed to. The Chair appointed Mr. A. C. Wood as teller.

The Secretary—By direction of the Association I cast the unanimous ballot for the list of officers reported by your Committee.

The Teller—The ballot seems to be unanimous, as cast by the Secretary, for the officers recommended by the Committee.

The President—You have heard the result of the ballot. The gentlemen named are declared the officers of the Association for the ensuing year. [Applause.] I suppose it is hardly worth my while to go through the formality of introducing Mr. Forstall as your next President—so well and favorably is he known to every member of the Association.

Mr. Forstall—Gentlemen, I thank you most heartily for this evidence of your goodwill; and I will try to deserve the honor you have conferred upon me. [Applause].

[To be continued.]

Electric Units.

By D. MONNIER, C. E.

(Continued from page 235.)

GALVANOMETERS.

The construction of galvanometers rests upon the discovery of Oersted. A metallic thread, traversed by a current, acquires the property of acting upon a magnetized needle. It tends to move it perpendicularly to its proper direction. The character (positive or negative) of the deviation of the needle depends upon the direction of the current.

Ampere has formulated the law according to which this deviation takes place as follows:

Conceive an observer placed in the circuit in such a way that the current enters by his feet and passes out by his head; the face being turned towards the magnetic needle this is deflected in such a way that the north pole is carried to the left of the observer.

In applying this law to a rectangular (codre?), in which a current circulates, and at the center of which a magnetic needle is suspended, we see that each of the sides of the (codre?) act in the same way upon the needle. Consequently, by multiplying the number of strands we amplify the action of the current upon the needle.

We augment the mobility of the needle, or its sensibility of the instrument, by employing a silk thread for the suspension of the needle, and, instead of a single magnetic bar, using an astatic system, *i.e.*, composed of a number of pairs of needles having practically the same magnetizing force, and being disposed parallel to each other, with the poles arranged contrary to each other. The action of the earth upon this system is equal to the difference of the actions which it exerts upon each of the needles, and can be made as small as desired.

There are two forms of galvanometers, viz., sign and tangential.

In the sign galvanometer the frame is movable around a vertical axis. We commence by placing the frame in the plane of the magnetic meridian—that is to say, in the plane of the needle whose index should be at the zero of the graduation. When the current causes the needle to deviate we turn the frame so that it will be in the new plane of the needle, and read the angle through which the frame has turned. We have then, strictly,

$$C=\frac{a}{2\pi n}-HS \text{ in } \varphi$$

Of which a=radius of the circle, in centimeters, upon which the galvanometric wire is wound; H=horizontal component of the magnetism of the earth expressed in the C. G. S. system, the value thereof for Paris being approximately equal to 0.195. φ being the angle of deflection, C would be expressed in absolute C. G. S. units, and by multiplying the number obtained by 10, we should have the value of the current in Amperes.

In the tangential galvanometer the frame is fixed, and we read the deflection of the needle directly.

The theory of this galvanometer supposes that the poles of the needles rest always at the same distance from the different parts of the current. In order o establish this condition it is necessary that the magnet be very small in

proportion to the diameter of the circular frame. We then have—

$$C=\frac{a}{2\pi n}H \text{ tang. } \varphi \qquad \text{(II.)}$$

a, n, H, and φ having the same signification as before; and by multiplying by 10, the value of C thus found, we have the value of the current in Amperes.

The results given by equation II. will be more and more strictly correct as the angle φ is diminished. In this case, in order to appreciate the smallest variations of the current, it is necessary to magnify the movement of the needle.

This is easily done, by fixing on the system of needles a very light mirror, upon which is thrown a luminous ray passing through a small vertical slit, or through a round hole traversed by a thread, whose image is reflected by the mirror upon the scale. The least movement of the mirror is shown upon the scale, and the path described is equal to that which would have been described by an index having a length equal to double the distance of the mirror from the scale.

In tracing the path passed over by the luminous ray we see, in effect, that when the mirror turns through the angle φ, the luminous point describes an angle equal to 2φ, and, as for very small angles, 2 tang.φ=tang. 2φ, we have at once the value of tang. φ. If the scale is at one meter distance from the mirror we can appreciate a variation of 1′ in the position of the mirror, inasmuch as we can read the displacement within about one-half a millimeter.

We can appreciate smaller angles of deviation even by increasing the distance of the scale from the mirror. This means of amplifying the movements of the mobile parts of instruments of measure is in general use in electrometry, and under this form the galvanometer is most commonly used.

Galvanometers are constructed in a multitude of forms according to the nature of the currents which they are intended for—some for the most delicate and others for the strongest currents. The galvanometer of Obach is a tangential one, whose frame is movable around a horizontal axis, so that it may be inclined more or less to the plane of the needle, and the deviation of this for a given current is proportional to the cosine of the angle which the frame makes with the vertical, hence it is called a cosine galvanometer.

Those of M. Marcel Deprez and Messrs. Ayrton and Perry, are very convenient for measuring strong currents. They consist essentially of a galvanometer frame and a very light needle, movable in the magnetic field of a strong permanent magnet. The intensity of this artificial magnetic field acts sufficiently upon that of the terrestrial magnetism, so that we can dispense with (orienter?) the instrument. The directing force being considerable, and the needle very light, the latter rapidly takes its position of equilibrium, which is a precious advantage when observing sudden strong variations of the current.

These instruments are graduated experimentally, and a table is annexed to each apparatus giving immediately the value in Amperes of the variations observed.

The torsion galvanometer (Siemens and Halske) is formed of a magnet having the shape of a vertical cylinder suspended by a thread of silk, and maintained by a helicoidal metallic spring. The instrument is set in such a way that the index attached to the magnetic bar may be at the zero of graduation. When the bar is deflected by the passage of a current we bring it back to zero by twisting the spring, the angle of torsion being, within these limits, proportional to the force necessary to lead the needle back to zero, measures this force—*i.e.*, the current which passes through the apparatus. The graduation is fixed experimentally. The one before you, for a deviation of one degree, measures a current of 0.000075 Amperes.

Electro-Dynamometers.

We now come to another class of instruments, the electro-dynamometer based upon the mechanical action which one current exercises upon another. An electro-dynamometer may be likened to a galvanometer whose magnetic needle is replaced by a movable bobbin which is traversed by a current. In a state of rest the planes of the fixed and of the movable bobbins cut each other at right angles, following the vertical axis of the instrument. The fixed bobbins are independent of each other; but each can be put into the circuit of the movable frame.

The instrument being placed in a circuit traversed by a current, the movable frame is displaced and tends to take a position parallel to the fixed bobbin. When the displacement is small the mechanical force which produces this is, all other things being equal, proportional to the product of the currents which traverse the two bobbins, *i.e.*, as the square of the current to be measured. If we lead the needle back to zero, the angle of torsion of the spring will be proportional to the mutual action of the currents, that is to say, will measure the square of the current which passes through the apparatus.

The instrument is graduated experimentally by noting the torsion of corresponding currents of known value. The indications of the electro-dynamometer are very precise; and, moreover, it is the only instrument which permits of comparing directly alternating currents. In effect, the sense of the current changes at the same time in the fixed and in the movable bobbin, and the mechanical action exercised between the two bobbins does not change its sense (from plus to minus, or vice versa) and the deviation of the needle gives the measure of an alternating as well as that of a continuous current. In the galvanometer, on the contrary, each reversal of current changes the direction of the force which acts upon the magnetic needle, and if the alternation is very rapid the tendency of the needle is to remain stationary, *i.e.*, the instrument does not furnish any indication. The different instruments of which we have spoken, galvanometers and electro-dynamometers, furnish only relative indications; that is to say, the proportions which exist between the values of different currents. In order that their indications may be transformed in numbers of units, they must be standardized by comparison with an absolute instrument, as we have indicated above, or by one of the following proceedings, which are less delicate in their application.

Calorimetric Method.

When a current traverses a conductor it heats it, and if, by means of a calorimeter, we measure the quantity of heat that is developed in a given time, we shall have the means of valuing the current.

We know that the work produced in the time, t, by a current, C, traversing a conductor whose resistance is R is expressed by the equation $W=C^2Rt$.

Now, by the last experiments of Joule, 1 gramme-degree equals 4.2118 units of work (Ohm–Volt system), and one unit of work is equal to 0.23743 gramme-degree. Consequently, the current, C, traversing a conductor with a resistance, R, will develop, in one second, 0.23743 C^2R calories.

By measuring the number of calories given off in a given time we easily determine C in a function of R.

The calorimeter which Mr. Joule used for his experiments was composed of a vase of copper holding about five quarts of water, into which was plunged a conducting wire, made from an alloy of platinum and silver, of which the resistance (being about one ohm) was accurately determined by comparison with the standard of the British Association. A thermometer indicates the temperature of the water, and the quantity of heat absorbed can be deduced.

The calorimetric method gives the value of C^2, is independent of the sense of the current, and consequently is alike applicable to the measurement of alternating and of continuous currents.

The Electro-Chemical Method.

This method is founded upon the laws of electro-chemical decompositions discovered by Faraday. These laws which have been verified by experiment, are the following:

1st. The chemical power of a current is the same in all its parts.

2d. The quantity of a substance decomposed is proportional to the quantity of electricity which passes in a given time—that is to say, to the current.

3d. When the same current traverses several electrolytes in succession the weights of the elements deposited in each of them are proportional to the chemical equivalents of the elements.

These laws enable us to define a current by the chemical work which it can perform; and that weight of any substance which is decomposed in one second by a current of one Ampere is called the "Electro-Chemical Equivalent" of that substance.

According to the last experiments by Mr. Mascart one Ampere decomposes 0.00009375 grammes of water in one second, or disengages one gr. of hydrogen in 26 hours and 40 minutes. From this figure we see that the weight in grammes of any substance which a current of one ampere will deposit in one minute is equal to the atomic weight of the substance divided by 3200.

Here we have a very simple and exact means of determining the absolute value of a current, and consequently the means of graduating experimentally both galvanometers and electro-dynamometers.

The apparatus employed in the electro-chemical measurement of currents has received the name of "Voltameter." These are of two kinds, known as the gas voltameter and the metallic decomposition voltameter.

In the first, the volume of gas produced by the decomposition of water in a given time is measured; and in the second we weigh the amount of metal precipitated from a saline solution. The latter give more exact indications than the former. We operate either with a salt of copper or of silver. The atomic weight of silver being much higher than that of copper, the voltameter with silver salts gives more rapid and more exact indications, and is very convenient in the determination of weak currents. In order to fix this idea, take an example—suppose that a current whose value we are seeking has precipitated 54 centigrammes of silver in ten minutes. We know, from what is stated above, that one ampere precipitates 0.0675 gr. of silver in one minute, whence we have

$$C=\frac{0.54}{10\times 0.067592}=0.8 \text{ ampere.}$$

Finally, we can standardize galvanometers by making use of a known electromotive force, for example—a battery composed of a certain number of zinc-chloride of silver elements whose electromotive force can be considered as practically constant.

The electromotive force of an element being 1.068 volt, if we employ 25 of these elements the total electromotive force of the battery will be 26.7 volts. If we form a circuit having (1) a battery of known electromotive force and resistance; (2) a known resistance coil; (3) a galvanometer which we wish to standardize—the value of the current for different values of the resistance coil may be determined, and from these results the "constant of the galvanometer" can be determined by trial. The deviation of the needle, in case of a minor galvanometer, or the function of the sign or tangent in case of such galvanometers multiplied by this constant to give the value of the current in amperes.

There is no material standard for the "Coulomb;" but from the definition which has been given, quantity expressed in coulombs is equal to the product of the current (expressed in amperes) multiplied by its duration in seconds.

The unit of capacity called the "Farad," can be represented by a material standard; and this would be the capacity of a condenser standardized in such a way that it would contain 1 coulomb when it was charged with an electromotive force of 1 volt. But this unit would be too great in practice, and we use the micro-farad, which is equal to the one-millionth part of a farad, and equal to ten one-fifteenth units C. G. S. of capacity.

The British Association has not yet established a standard of capacity, but we find in commerce condensers gauged to give multiples or sub-multiples of the micro-farad.

The St. Louis Gas Illumination.

The projected illumination of the streets of St. Louis, Mo., the detailed plan of which appeared in our issue of October 2d, has been a great success. A correspondent, in describing the impression produced upon seeing it, says:

"You will understand that they hold a yearly fair in St. Louis, and some period during its continuance is fixed upon in which to have a grand illumination. It is regarded as a great occasion, not only by the people of St. Louis but by those who live for miles around. I will do the justice to say I never before witnessed so grand an affair. The streets for about two miles were lit up by some 25,000 brilliant gas burners. These were all covered with globes of various colors and hues, so arranged as to give the best effects. They were clustered in groups of various kinds, in the form of arches on the sides and even across the streets, in groups, festoons, etc.; and the extent and cost of the affair may be imagined when it is remembered that it required the laying or placing of about seven miles of gas pipes to supply the lights. The effect of the illumination was the finest that could be conceived. It was very enjoyable—that is, every one seemed to enter into the spirit of the occasion, and to enjoy it to the full."

A Gas Man Made a Mayor.

Mr. A. M. Norton, of Nashua, N. H., the widely-known and popular superintendent of the Nashua Gas Light Company, has been called by the citizens of that place to preside over its municipal doings for the coming year. We think the good people of Nashua are to be congratulated upon the accession of Mr. Norton to his new position, as we see no reason why he will not govern their affairs in the same spirit of enterprise which has always characterized his management of the doings of the Nashua Gas Light Company. The Nashua *Daily Telegraph* gives the following brief personal sketch of the new municipal officer:

Hon. A. M. Norton, who has just been inaugurated mayor for the ensuing municipal year, is a native of Greenland in this State. He was educated in the public schools of that town and in Brackett Academy, from which he graduated. After attaining his majority he—like many another New Hampshire boy—became a citizen of Massachusetts, and, 25 years ago, a resident of East Boston, where he held various responsible positions connected with gas manufacture. Nine years ago he became a resident of Nashua, and engineer and superintendent of the Nashua gas light company. Under his judicious management and practical ability the quality of the gas consumed in this city has steadily increased and the price lessened. It may of a truth be said that there is not a man in Nashua who is in greater favor with people of all classes. Of fine physical proportions, a most cheerful and companionable man, generous, instinctively a judge of men and capable of approaching them so as to obtain their confidence, he unites those qualities which secure firm friends, and which controlled enough of Republican votes to elect him to the office he holds. Mayor Norton has nerve and a mind of his own, and it is safe to predict that there will be no antagonizing of the opposition in the government, but that everything will work smoothly, and for the best good of the city."

Price of Gas in Montreal, Canada.

The Montreal *Star* is agitating the matter of cheap versus dear gas in that place. It is engaged in the attempt to prove that the price of gas in Montreal should be the same as that now paid in Manchester, England; and seems to think that the operation of gas manufacture should be under the control of the municipal authorities.

It strikes us that $1.90 is a pretty low figure for gas in a city situated as Montreal is. Perhaps it would be a good idea to invite the Editor of the *Star* to try his hand at gas making!

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

The Future of the Gas Business.

NEW YORK, Nov. 27, 1882.

To the Editor AMERICAN GAS LIGHT JOURNAL:

In the paper entitled "The Future of the Gas Business," which was read by Mr. Pratt before the American Gas Light Association, in Pittsburgh, last October, I find the following the paragraph:

"The future success of the gas interest will demand the acceptance and use of every real improvement, the strictest economy in every department of expenditure, the utilization of our residuals by a combination of interests, so that much larger profits may be derived from them, the acceptance by the stockholders of a reasonable and, at the same time, ample return upon the capital, no watering of stocks, and a larger division of the surplus earnings to their customers in a reduced price of gas." Had Mr. Pratt commenced and ended with those words, which contain good advice and evince sound sense and good judgment, he would not have felt it necessary to forestall himself with such words as he uses when he says, "The paper which I am about to read, as you will very soon see, presents some views which are novel, and perhaps somewhat radical; and I can hardly expect that it will receive the cordial assent or approval of a very large number of the members. If then, gentlemen, you agree with me in this statement of my views," etc., "and if, on the contrary, as is very likely to be the case, you think my views radical, visionary and unsound—if you think me a foolish alarmist, presenting bugbears to be laughed at, scouted—then all I have to say is:—Let this paper, if it is printed with your minutes, be read five years hence and see who is the prophet." Mr. Pratt goes on with statements and statistics about railroad companies, and telegraph companies, compares gas companies meetings with masonic lodges; gives his opinion about electric light, takes upon himself the role of a prophet, etc., etc., most of which have nothing whatever to do with the gas business. Opinions are not what is needed, but facts—and this is not the age of prophets. The gist of Mr. Pratt's paper is that gas companies make too much money, and they should compel the public to step in and exercise a control and surveillance of the business, and tell them how much money they should make, etc., and then the public would be satisfied and everything go on lovely. Does Mr. Pratt think *he* needs advice about what compensation his employees should have, or how many pounds of coal to put into a retort?

Does not Mr. Pratt know that the public—I speak in a broad sense, referring more especially to the people of intelligence and the business portion of the community in contradistinction to the croakers and that class of people who interest themselves much more in other people's affairs than they do their own—do not entertain such views towards even gas companies as he would lead unobserving people to suppose. Unless it is plain that gas companies abuse their chartered privileges, the people about whom Mr. Pratt has so much to say have no more right to dictate to them in their business than to interjere in any other business of private corporations. They know little or nothing about the details of the business, and care less. But in almost every community there are persons who make it their first business to talk of other people's affairs; they are never successful in anything themselves; they lay around for something to turn up, hoping at some time to get an office from the general government or the municipality, when they can receive a good salary and do nothing to earn it. These people know a great deal about everything; they can tell anyone how other peoples business should be transacted, always jealous and envious of the success of others, and who cannot achieve success should they mind their own business and work for it.

These are the people who have most to say about the enormous profits of gas companies; and they would not refuse to be appointed city inspector of gas and meters, or as auditor of gas company's accounts, and have the gas company taxed to pay a good round salary, and if, in consequence, it added a portion to the cost of gas, you would hear nothing about it from the holders of the positions as long as it enabled them to hold the offices.

Yours, etc.,

MANAGER.

THE AMERICAN
GAS LIGHT JOURNAL

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SATURDAY, DECEMBER 2, 1882.

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W. B. Scott & Co.,)
34 PINE STREET, NEW YORK CITY.

DECEMBER 2, 1882.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share. ☜

	Capital.	*Par.*	*Bid.*	*Asked*
Gas Co.'s of N. Y. City.				
Central	$466,000	50	75	85
Harlem	1,800,000	50	90	95
" Bonds	170,000			103
Manhattan	4,000,000	50	210	215
Metropolitan	2,500,000	100	175	180
" Bonds	658,000		106	108
Mutual	5,000,000	100	101	104
" Bonds				
Municipal	1,500,000	100	170	175
" Bonds	750,000		106	110
New York	4,000,000	100	110	115
Northern	270,000	50	90	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	105	111
Citizens	1,200,000	20	68	72
" S. F. Bonds	320,000	1000	105	107
Fulton Municipal	3,000,000	100	70	80
Peoples	1,000,000	10	40	45
" Bonds	290,000		104	107
" "	250,000		88	90
Metropolitan	1,000,000	100	70	75
Nassau	1,000,000	25	50	55
" Ctfs.	700,000	1000	90	93
Williamsburgh	1,000,000	50	50	55
" Bonds	1,000,000		100	101
Richmond Co., S. I.	300,000	50	70	75
" Bonds	40,000	—	—	—
Out of Town Gas Companies.				
Buffalo Mutual, N.Y	750,000	100	72	75
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	—	—
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G. & C. Co.			178	180
Consolidated, Balt.			42	43
Bonds			137	—
East Boston, Mass	220,000	25	122	128
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	120	123
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
Jersey City	750,000	20	155	160
Jacksonville, Ill	120,000	50	100	...
Lewistown Maine	400,000	100	—	100
Laclede St Louis Mo.	1,200,000	100	117	—
Montreal, Canada	2,000,000	100	186	187
New Haven, Conn		25	144	—
Oakland, Cal			32	33
Peoples, Jersey City			75	80
" " Bds.			...	...
Pittsfield, Mass			120	130
Rochester, N. Y.		50	70	80
Wilmington, Del.		50	174	...
Yonkers		50	30	32
St. Louis Missouri	600,000	50	250	254
San Francisco Gas-Co., S. Fr'isco Cal.			55	57
Toledo, Ohio			95	97
Troy, Citizens	600,000	100	—	—
Washington, D. C.	1,500,000	20	215	220
" Scrip	375,000	15	245	250

The following gas stocks were sold at auction: 300 shares Williamsburgh gas company, at 50½; $15,000 Williamsburgh gas bonds, at 98½.

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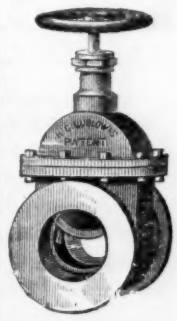

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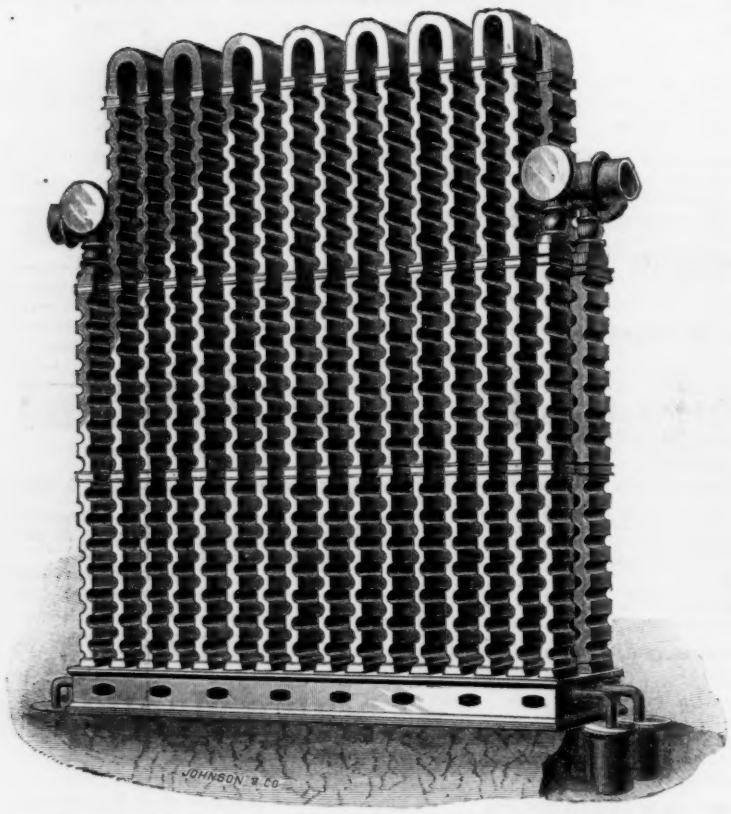

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Gloucester, Mass.	Woburn, Mass.	Attleboro, Mass.	Paterson, N. J.
Newton & Water-town, Mass.	Peoria, Ill.	Calais, Me.	Dover, N. H.
	Clinton, Mass.	Fall River, Mass.	Waltham, Mass,
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Gas Light Companies are cordially invited to visit Yonkers and inspect this new system, which, if electricity *should* eventually drive them out of the field of illumination, will open to them another field still more vast and fruitful, and from which they never can be dispossessed. The Westchester Gas Light Company of the city of Yonkers employes the Lowe Process for making its gas. Here, then, can be seen, side by side in business competition, the Strong and the Lowe against the Motay and the old coal gas methods, and each observer will be enabled to form his own opinion as to their relative power and value. The STRONG GAS FUEL AND LIGHT COMPANY is the proprietor for the State of New York of the Strong Patents, five in number, and of the Lowe Patents, two in number. All applications for licenses or for information should be addressed, as above, to

R. W. VAN PELT, *President of the Company.*
And also President of the Yonkers Fuel Gas Co., and of the Westchester Gas Light Co.

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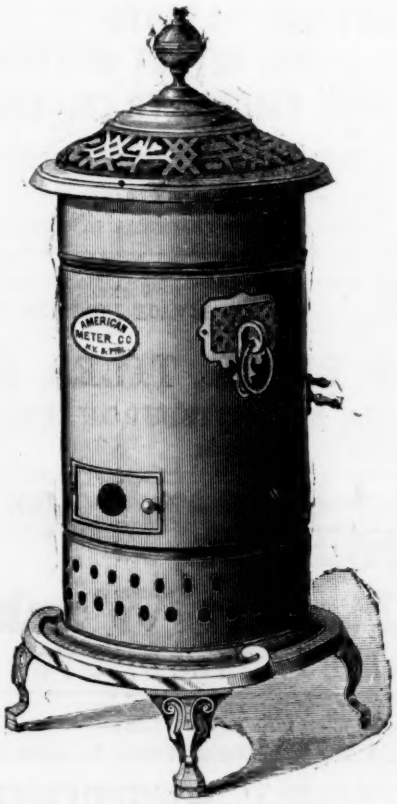

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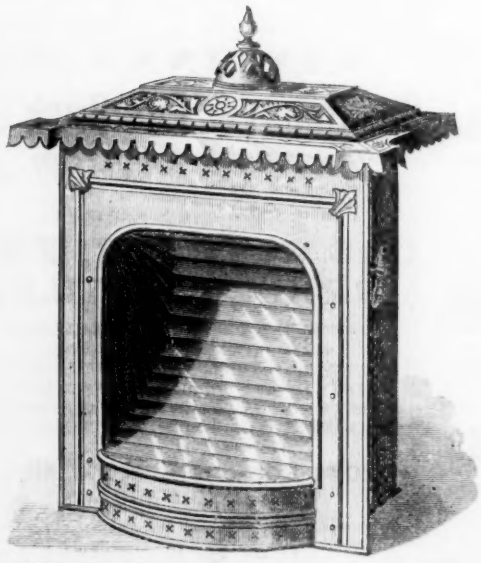

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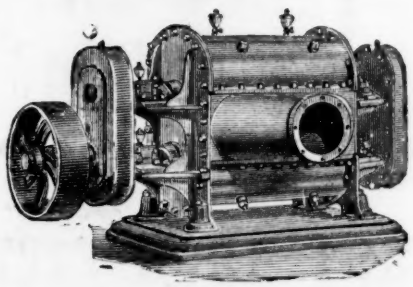

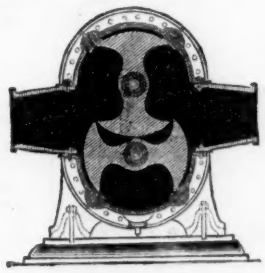

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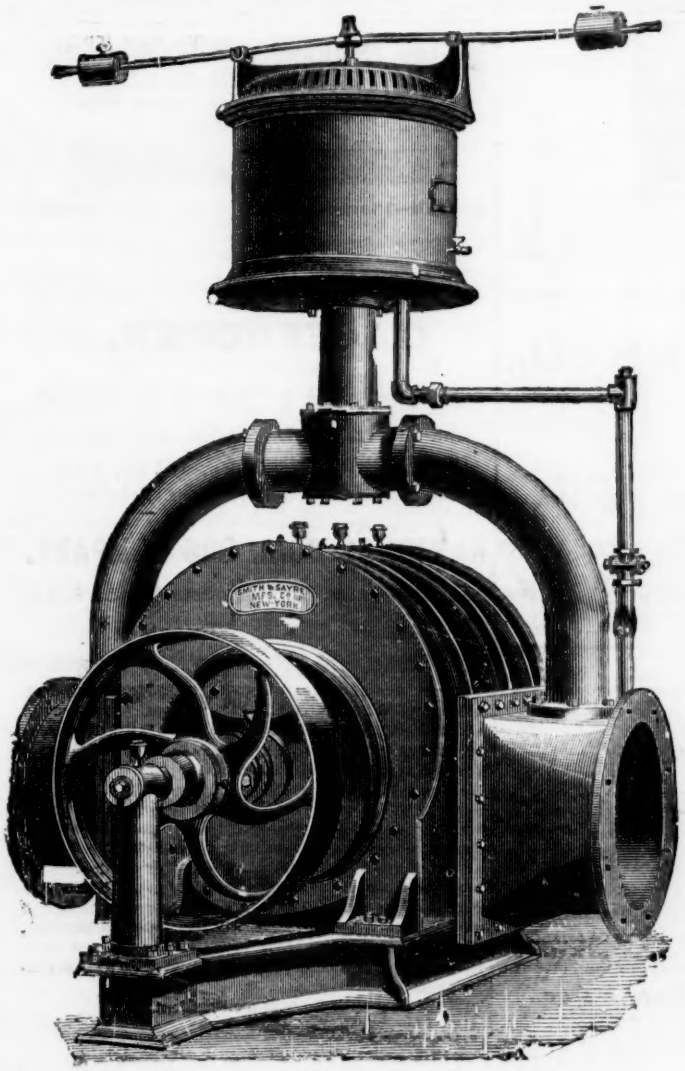

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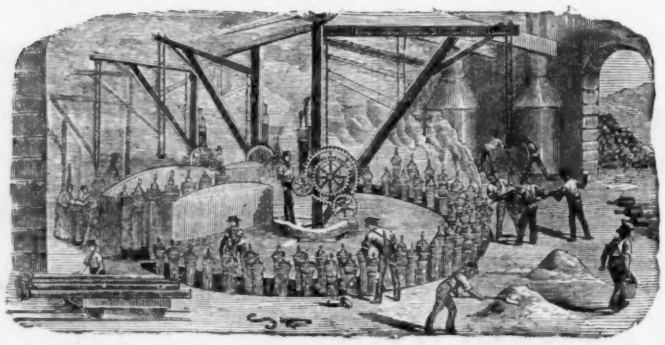

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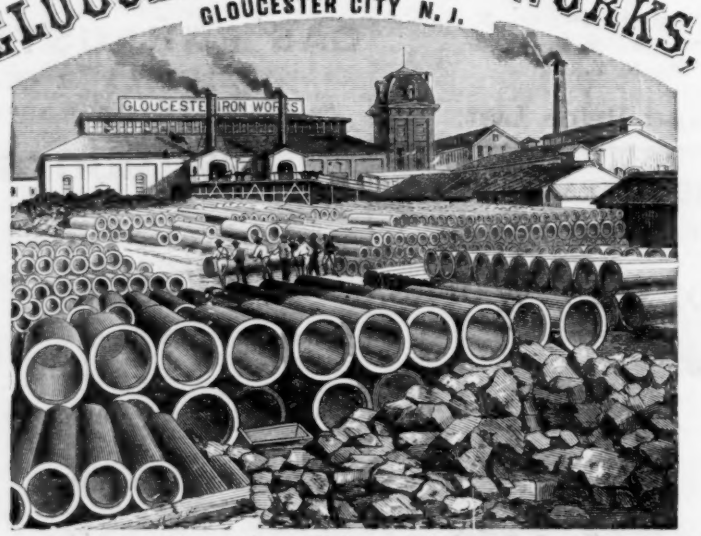

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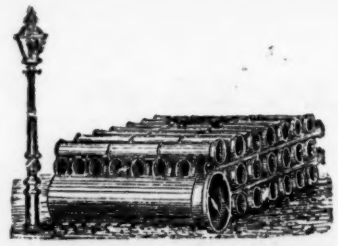

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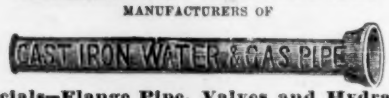

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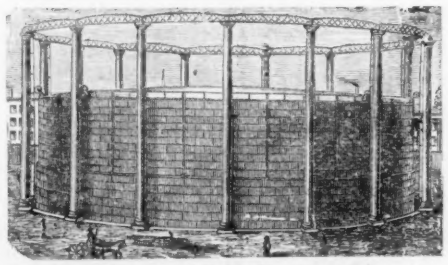

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CONSOLIDATED CO., BALT., U. S. A.	2,000,000
Croydon Company	1,500,000
Danish Company, Copenhagen	150,000
Deal Company	200,000
Derby Company	1,500,000
Dover Company	750,000
Dowlais Company	100,000
Doual, France	500,000
Driffield Company	100,000
Dublin Company	3,000,000
Dudley Company	750,000
Dukinfield Local Board	500,000
Edinburgh and Leith Company	1,500,000
Enfield Company	300,000
EQUITABLE CO., BALTIMORE, U. S. A.	1,000,000
Essen Company, Germany	300,000
European Company, Rouen	250,000
Falmouth Company	150,000
Farnworth Company	400,000
Frankfort Company, Germany	300,000
Gera Company, Germany	300,000
Glossop Company	300,000
Gloucester Company	1,250,000
Goole Company	250,000
Great Western Railway Company	300,000
Guildford Company	300,000
Halstead Company	150,000
Harrogate Company	250,000
Harrow Company	250,000
Hastings Company	1,500,000

	Ft. per Day.
HAVANA COMPANY, CUBA	750,000
Heilbronn Company, Germany	200,000
Heywood Local Board	600,000
Holywood Company, Ireland	125,000
Huddersfield Corporation	300,000
Huy Company, Belgium	70,000
Ilkeston Local Board	250,000
Ilkley Company	200,000
Inverness Gas Commrs	250,000
Kidderminster Company	750,000
Kidsgrove Company	100,000
Kingston (Hull) Company	400,000
Lea Bridge Company	300,000
Leeds Corporation	14,000,000
Leominster Company	150,000
Leyden Company, Holland	500,000
Lincoln Company	600,000
Liverpool Company	2,000,000
Maidstone Company	1,000,000
Malines, Belgium	250,000
Marseilles Company, France (two)	3,000,000
METROPOLITAN CO., N. Y. CITY, N. Y.	2,000,000
Melbourne Company, Australia (3)	4,500,000
Mons, Belgium	500,000
Newmarket Company	150,000
NEWPORT, RHODE ISLAND, U. S. A.	250,000
Nice Company, France	600,000
Northfleet Company	200,000
Nottingham Corporation	6,250,000
Oldbury Local Board	500,000
Otley Company, near Leeds	200,000

	Ft. per Day.
Paramatta Company, N. S. W	100,000
Planen, Saxony	600,000
Plymouth Company	2,000,000
PROVIDENCE CO., R. I., U. S. A	1,500,000
QUEBEC COMPANY, CANADA	250,000
Radcliffe Company	750,000
Ramsgate Local Board	1,000,000
RICHMOND, INDIANA, U. S. A	250,000
Reigate Company	200,000
ST. JOSEPH, MO., U. S. A	250,000
Salford Corporation	5,250,000
Smethwick Local Board	750,000
Sunderland Company	1,500,000
Sydney Company, Australia	1,000,000
Tipton Local Board	400,000
Tottenham Company	1,000,000
Tonbridge Company	150,000
Waltham Abbey Company	150,000
Warwick Gas Company	500,000
W. Bromwich Imp. Comms	1,000,000
Wellington Company, Salop	150,000
West Ham Company	1,500,000
Weston-super-Mare Company	500,000
WHEELING, W. VA., U. S. A	500,000
Wigan Coal Company	150,000
Willenhall Company	250,000
WILLIAMSBURGH COMPANY, U. S. A.	1,200,000
Woolwich Equitable Company	400,000
Yeadon Company	500,000
Yeovil Company	250,000

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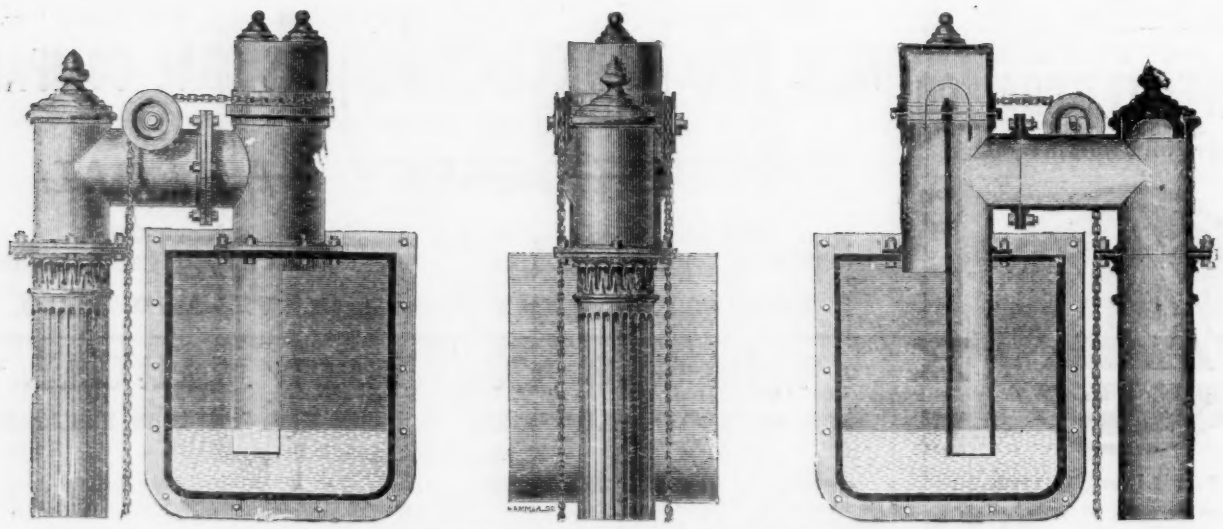

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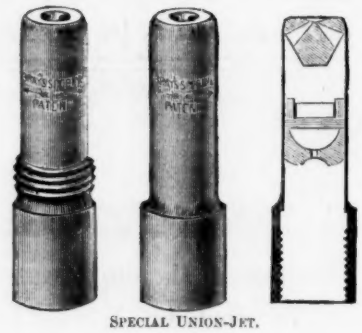

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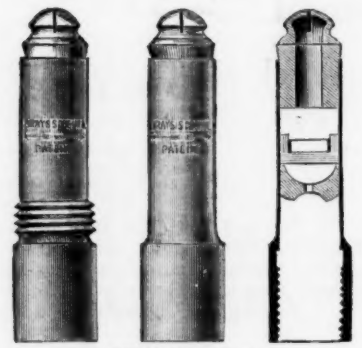

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	Inches.	Cubic Feet.	Candles.	Candles.	Candles.
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" Special Slit-Union No. 7.....	.50	4.74	19.30	20.25	4.05
" " " No. 6.....	.50	4.10	16.61	20.25	4.05
" " " No. 5.....	.50	4.24	16.97	20.01	4.00
" " " No. 4.....	.60	3.49	12.58	18.02	3.60
" " Union Jet No. 7.....	.50	4.84	19.13	19.76	3.95
" " " No. 6.....	.55	4.32	17.10	19.79	3.95
" " " No. 5.....	.60	4.14	15.65	18.90	3.78
" " " No. 4.....	.55	3.38	12.04	17.81	3.56
" Regulator Union Jet No. 7.....	.50	4.99	17.69	17.72	3.54
" " " No. 6.....	.50	5.18	17.03	17.01	3.40
" " " No. 5.....	.60	4.87	13.71	15.68	3.13
" " " No. 4.....	.60	3.97	11.46	14.43	2.88

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